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UTILIZATION OF SURGICAL SERVICES IN ALBERTA

by

PENELOPE JOAN MACDONALD

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Kyung Bay
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....

Janet L. Storch

Date Dec. 16, 1982

ABSTRACT

Determination of the presence or absence and magnitude of surgical utilization rate variation among selected areas in Alberta constituted the problem to be investigated in this study. Through the application of patient origin-destination studies, and the calculation of per capita surgical utilization rates (for six surgical categories) using longitudinal, age-sex adjusted, retrospective data, and the application of a community-based method of computation, the following aspects of surgical utilization were investigated: 1) the travel patterns of patients seeking surgical care, and the patterns of resource commitment by hospital groups, 2) the patterns and magnitude of surgical utilization rate variation among areas in Alberta, and 3) the degree to which geographic location could be used to account for the variation among district surgical utilization rates using multiple regression techniques.

The major findings of this study include:

1. Patient travel for surgical care was related to the size of the hospital(s) located in the patient's resident area.
2. From 1971 to 1978, the utilization rates for appendectomy, hysterectomy, cholecystectomy, and tonsillectomy and adenoidectomy declined; the Caesarean section rate doubled, and the prostatectomy rate remained almost unchanged.

3. The Lethbridge and Grande Prairie areas were often associated with utilization rates markedly higher than the provincial rate. Conversely, the Medicine Hat area generally had surgical rates well below the provincial average.
4. Once the influence of time had been controlled, the variables which described patient residence accounted for a very minor amount of rate variation (with the exception of hysterectomy).

With regard to these findings, it was evident that: 1) there is surgical utilization rate variation among areas in Alberta, 2) the magnitude of the variation is dependent upon the particular set of areas studied, and 3) geographic location accounts minimally for surgical rate variation. These conclusions indicate the necessity of calculating accurate utilization rates, and challenge the premise that geographic location can be used to explain variation among district surgical utilization rates.

Four recommendations are made regarding the suggested emphasis for future research, and the need for more information prior to the establishment of surgical utilization rate standards for the province.

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TABLE OF CONTENTS

Page

ABSTRACT iv

ACKNOWLEDGEMENTS vi

TABLE OF CONTENTS vii

LIST OF TABLES x

LIST OF FIGURES xii

CHAPTER

I INTRODUCTION 1

1.1 Statement of the Problem 1

1.2 Significance of the Study 2

1.3 Research Approach and Objectives 4

1.4 Assumptions and Limitations 5
   1.4.1 Assumptions 5
   1.4.2 Limitations 6

1.5 Definition of Terms 8

1.6 Format of the Thesis 9

II A SELECTIVE REVIEW OF THE LITERATURE 10

2.1 Conceptual Model of Surgical Utilization 10
   2.1.1 Macro-System Perspective 13
   2.1.2 Micro-System Perspective 15
   2.1.3 Need, Demand, and Utilization 17
   2.1.4 Supply/Demand Analysis 19
   2.1.5 Summary 22

2.2 Determinants of Surgical Utilization 22
   2.2.1 Societal Determinants 23
   2.2.2 Individual Determinants 28
   2.2.3 Health Service System Determinants 31
   2.2.4 Summary 38

2.3 Selected Aspects of Surgical Utilization 38
   2.3.1 Concept of Unnecessary Surgery 39
   2.3.2 Surgical Rates in Canada 49
   2.3.3 Surgical Utilization Indices 52
   2.3.4 Summary 54

2.4 Selected Surgical Operations 55
2.4.1 Appendectomy 55
2.4.2 Caesarean Section 57
2.4.3 Prostatectomy 58
2.4.4 Cholecystectomy 59
2.4.5 Hysterectomy 61
2.4.6 Tonsillectomy and Adenoidectomy 63
2.4.7 Summary 66

2.5 Patient Origin-Destination Methodologies 66
2.5.1 Patient Origin-Destination Flow Patterns . 67
2.5.2 Delineation of Service Areas and Service Populations 70
2.5.3 Comparative Studies of Resource Utilization 76
2.5.4 Summary 80

2.6 Summary of Literature Review 81

III METHODOLOGY 84

3.1 Research Strategy 84

3.2 Data Sources 89
3.2.1 PAS (Professional Activities Studies Data) 89
3.2.2 Census Data 91
3.2.3 Selected Government Reports 94

3.3 Data Analysis Strategies 95
3.3.1 Provincial Analysis 95
3.3.2 Patient Origin-Destination Travel Patterns 96
3.3.3 Analysis of Surgical Utilization Rate Variation 101

3.4 Summary 118

IV PRESENTATION AND DISCUSSION OF RESULTS 120

4.1 Alberta Health Care System - Selected Aspects .. 120

4.2 Surgical Utilization - Provincial Perspective .. 128
4.2.1 Acute Care Utilization 129
4.2.2 Surgical Utilization 129

4.3 Patient Origin-Destination Studies 135
4.3.1 District Perspective - Relevance Indices.. 137
4.3.2 Hospital Perspective - Commitment Indices. 145

4.4 Analysis of Surgical Utilization Rates 149
4.4.1 Preliminary Analysis of Area Rates 150
4.4.2 Multiple Regression Analyses 175

4.5 Summary 194

V SUMMARY AND RECOMMENDATIONS 195

5.1 Summary of the Study 195

5.2 Major Findings 196

5.3 Conclusions 199

5.4 Recommendations 202

REFERENCES 204

APPENDIX A METHODOLOGY SUPPLEMENT 218

APPENDIX B RESULTS SUPPLEMENT 229

LIST OF TABLES

1. Comparative Utilization Data for Canada and the Provinces 1976, 1981 124

2. Number of Separations, Days of Hospital Stay, and Average Length of Stay by Four Age Groups for Total Acute Care Separations and Surgical Separations in Canada, 1971 and 1978 126

3. Surgical Separation Rates per 1000 Persons, Alberta, 1971-1978 132

4. Percentage by Column of Total Separations and Days of Hospital Stay (bracketed numbers) by Age-Sex Group (Separations for the years 1971 to 1978 have been combined) 133

5. Average Length of Stay in Days by Four Age Groups and by Sex for Total Acute Care Utilization and Six Surgical Categories (Separations for the years 1971 to 1978 have been combined) 136

6. Percentage of District Residents Having Surgery in the Hospital District of their Residence 138

7. District Perspective: Percentage of Area Residents Receiving Surgical Care at Selected Hospitals (Relevance Indices) 1971 and 1978 141

8. Hospital Perspective: Percentage of Surgical Separations Committed by Three Hospital Groups to Three Selected Areas (Commitment Indices) 1971 and 1978 146

9. Appendectomy - rate per 1000 age-sex adjusted persons 151

10. Caesarean Section - rate per 1000 age-sex adjusted persons 156

11. Prostatectomy - rate per 1000 age-sex adjusted persons 161

12. Cholecystectomy - rate per 1000 age-sex adjusted persons 164

13. Hysterectomy - rate per 1000 age-sex adjusted persons 168

14. Tonsillectomy and Adenoidectomy - rate per 1000 age-sex adjusted persons 171

15. Summary of Multiple Regression Analysis for Appendectomy 179

16. Summary of Multiple Regression Analysis for Caesarean Section 182

17. Summary of Multiple Regression Analysis for Prostatectomy 185

18. Summary of Multiple Regression Analysis for Cholecystectomy 187

19. Summary of Multiple Regression Analysis for Hysterectomy 189

20. Summary of Multiple Regression Analysis for Tonsillectomy and Adenoidectomy 191

21. Summary of Surgical Utilization Rate Deviation for Each Geographic Area From the Edmonton District Rate 193

LIST OF FIGURES

1. Conceptual Model of Surgical Utilization 12
2. Research Strategy 85
3. Maps Depicting Four Aggregations 107

CHAPTER I

INTRODUCTION

The variation of surgical rates among geographic areas has elicited questions concerning potential under and over utilization of service. As well, there is concern regarding the implications such rate variation may have on the quality of care provided and the costs incurred by patients and the health care system. In response to these concerns an examination of selected aspects of surgical utilization rates among areas in Alberta over the time period from 1971 to 1978 was undertaken.

1.1 Statement of the Problem

An interest in the health status of the population, the quality and accessibility of health services, and rising health care costs, has provided the impetus for continued research regarding patterns of health service utilization. In March 1981, the Alberta Hospital Utilization Committee (AHUC, 1981) released a report which detailed selected aspects of hospital utilization in Alberta. Specifically, the Committee had been given a mandate to "examine the hospitalization rate of Alberta residents with special emphasis on the number of surgical procedures being performed in Alberta hospitals" (AHUC, Appendix A, p. 1). The significant findings of the committee with respect to surgical utilization included: 1) that the rate of admissions for surgery in the Province of Alberta exceeded the Canadian average, and 2) that "significant variation in the rates of surgical operations between different regions of the province" existed (AHUC, p. 25).

Variation in surgical rates among ostensibly similar regions and within relatively small geographic regions is not a new phenomenon, and has traditionally been accompanied by concern regarding the possibility of excessive surgical utilization. An alternative hypothesis suggests that appropriate factors may not always have been taken into account by researchers measuring and defining surgical utilization, and therefore, reported variations may in part be an artifact of research design or methodology. Determination of the presence or absence and magnitude of surgical rate variation within the Province of Alberta constituted the problem to be investigated in this study. The problem has been viewed from a methodological stance; as such, descriptive statistics have been employed in an exploratory analysis of surgical utilization data.

1.2 Significance of the Study

Inflationary trends, current recession conditions, limited resource availability, and concern regarding equitable resource distribution have focussed attention on the development of measures that assess the effectiveness and efficiency of a health service system's performance; in this respect the applicability of this study is evident. The use of population-based measurements to derive per capita surgical utilization rates will enable meaningful comparisons of surgical utilization patterns among geographic areas. Comparisons of this nature will highlight significant variation in surgical utilization rates, and will indicate regions which require further investigation. Accurate and comparable per capita surgical utilization rates should support the efforts of government departments responsible for the planning of and resource allocation for surgical services, and should contribute information relevant to establishing surgical utilization rate standards or norms. Additionally, the analysis of eight years of data will facilitate trend analysis, while the patient origin-destination data will assist in the development of policy pertaining to the regionalization of surgical services.

From a methodological stance, this study's significance lies in its attempt to divide the province into similar regions, and in the demonstration of the computation of comparable rates for six surgical categories over an eight-year time period. Analysis of the relationship between users and providers of surgical services through a patient origin-destination study will circumvent some of the problems associated with previous research methodologies that have involved assumptions about, rather than actual delineation of, utilization patterns. Additionally, the utility and versatility of patient origin-destination studies using routinely-collected administrative data will be demonstrated.

1.3 Research Approach and Objectives

This study involved the use of retrospective age and sex-adjusted population and utilization data in an eight-year longitudinal analysis of surgical utilization in Alberta. In order to examine the surgical utilization experience of Albertans from 1971 to 1978, and to accurately investigate whether or not significant surgical rate variation had occurred in the same time frame, the following objectives were established:

1. To develop a methodology that would enable meaningful comparison of surgical utilization rates over time and among different geographic areas.
2. To examine the patterns and trends of surgical utilization for selected operations among areas in Alberta from 1971 to 1978.

Due to the absence of established theories pertaining to surgical utilization and to the use of population data themselves rather than the use of a sampling strategy to obtain data, hypothesis testing (or statistical inference) was not attempted. Thus, the analyses of the surgical utilization data in this study are primarily exploratory and descriptive in nature.

1.4 Assumptions and Limitations

In this section the assumptions and limitations considered pertinent to this study are outlined.

1.4.1 Assumptions

The following assumptions were made prior to the initiation of the study.

1. The practice patterns of surgeons in Alberta were assumed to be analogous to those of other professions; that is, a range of professional ability, commitment, and style of practice was assumed to exist.
2. The available utilization data included non-residents who received surgical care in Alberta hospitals, but did not include Alberta residents who sought care outside the province. Data pertaining to non-residents were removed prior to the analysis. Thus, the analysis was predicated on the assumption of a closed hospital system, as it was assumed that omission of data on these two groups would not have a significant impact on the analysis.
3. In order to use the patient origin-destination data, it was necessary to divide the province into mutually exclusive and exhaustive geographic areas. Since surgical utilization was of interest, the existing general hospital districts were assumed to offer appropriate geographic divisions. Subsequent aggregations of these districts into larger regions were

also undertaken in order to perform regional analyses.

1.4.2 Limitations

The limitations pertinent to this study arose primarily due to data and methodological limitations.

1. The Professional Activities Study (PAS) data used in this study are referenced to the number of separations from a particular institution, not to individual patients. Therefore, the number of surgical separations should be regarded as a close approximation to the number of different persons undergoing surgery, not the exact number.
2. The scope of this thesis did not permit an exhaustive examination of all surgical categories; six categories were chosen for this study.
3. Only surgery occurring on an inpatient basis was considered; all outpatient surgery was excluded from the analysis. This exclusion may introduce some error since the recording of day surgery (outpatient surgery) is not consistent across hospitals. Since only one of the surgical categories studied (tonsillectomy and adenoidectomy) could potentially be performed on an outpatient basis, and since the prevalence of outpatient surgery has only recently increased, the degree of error introduced by not considering outpatient surgical utilization data during the calculation of utilization rates was thought to be minimal.

4. The coding procedures used to categorize surgical utilization data have not remained constant during the period from 1971 to 1978. Despite this limitation care was taken to ensure that similar data were analyzed (see Appendix A.1).
5. The census data and the surgical utilization data were obtained from government sources, and therefore, verification of the accuracy of the data was impossible due to the quantity of data and the intricacies involved in its collection. Since these data have been collected for many years, and since quality control checks are routinely implemented, this limitation was not thought to unduly compromise the study.
6. The population figures used in this study were obtained from 1971 and 1976 census data. Population estimates for the intercensal years (1972-1975, and 1977-1978) were calculated under the assumption of a constant rate of increase (see Appendix A.2). Although both census data and intercensal estimates are subject to a certain degree of error, these were the only data sources available.
7. In order to perform the patient origin-destination study it was necessary to define the patient's origin. The use of point locations to indicate patient origin would have involved data analysis strategies beyond the scope of this thesis; therefore, hospital districts were used to describe the patient's origin.

8. The orientation of this thesis is primarily descriptive in nature. An attempt was made to establish association; causal relationships were not specified. Additionally, evaluation of the appropriateness of the level of surgical utilization was not attempted as such an analysis extended beyond the problem investigated in this study.

1.5 Definition of Terms

The following definitions provide clarification of the terms used in this study.

1. AVERAGE LENGTH OF STAY (ALOS): refers to "The average number of days stay of inpatients who were separated from the facility during the reporting year. It is calculated by dividing the total days stay by the number of separations during the reporting year" (Alberta Hospital Utilization Committee, 1981, Glossary).
2. GENERAL HOSPITAL: refers to "A hospital which provides primarily for the diagnosis and short-term treatment of patients for a wide range of diseases or injuries. The services . . . are not restricted to a specific age group or sex" (Alberta Hospitals and Medical Care, 1979, p.131).
3. OPERATION CODE: a numerical code found on the face sheet of the medical record which refers to a specific surgical procedure (see Appendix A.1).

4. PATIENT DESTINATION: refers to the acute care hospital to which the surgical inpatient is admitted.
5. PATIENT ORIGIN: refers to the hospital district within which the patient's residence is located.
6. PRIMARY DIAGNOSIS: refers to the diagnosis which is regarded as the primary reason for the patient's admission to hospital.
7. SEPARATION: the discharge or death of an inpatient is recorded as a separation.
8. SURGICAL SUITE: "The unit designed, staffed and equipped for the performance of surgical procedures and for the continuous observation and care of patients during the immediate post-operative or post-anaesthesia period" (Alberta Hospitals and Medical Care, 1979, p. 134).

1.6 Format of the Thesis

The text of this thesis has been divided into five chapters and two appendices. The preceding introduction constitutes Chapter I. Chapter II consists of a selective review of the literature, which provides background information for the development of the methodology contained in Chapter III, and the discussion of the data analysis found in Chapter IV. A summary, pertinent findings, and conclusions are presented in Chapter V. Appendices A and B contain supplemental information relevant to Chapter III and IV respectively.

CHAPTER II

A SELECTIVE REVIEW OF THE LITERATURE

The purpose of this chapter is to provide a literature review that will facilitate comprehension of the research objectives within an appropriate context, and to delineate the theoretical perspectives used in the development of the research methodology. The literature review includes five components: 1) an explanation regarding a conceptual model of surgical utilization, 2) an introduction to some of the determinants of surgical utilization, 3) a review of selected aspects of surgical utilization, 4) an overview of patient origin-destination studies, and 5) a summary.

2.1 Conceptual Model of Surgical Utilization

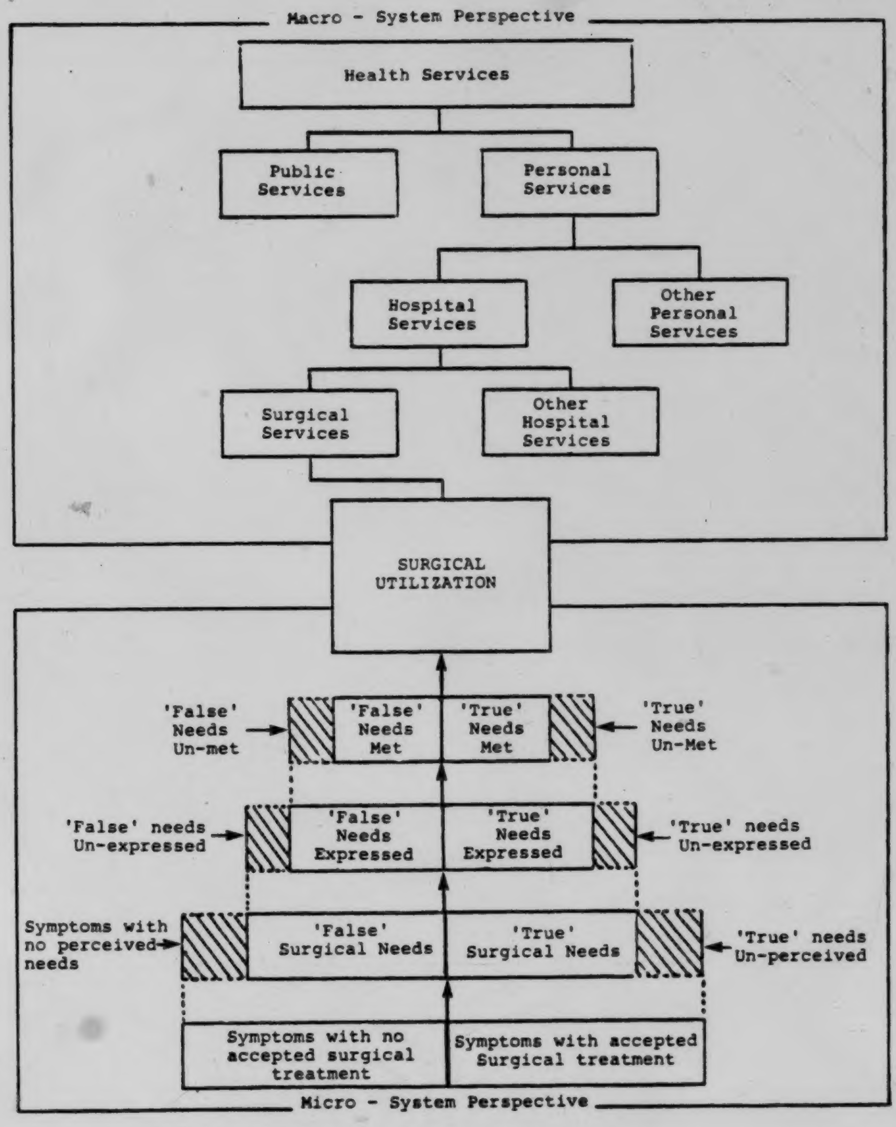
The perspective from which one conceptualizes surgical utilization is in part dependent upon one's background and particular orientation to the health care system. Since the primary objective of this study was to examine the variation in Alberta's surgical rates, the establishment of a common perspective from which to view surgical utilization was considered to be essential. Although the use of surgical services has been researched from various perspectives, there is no accepted theory of surgical utilization; therefore, researchers interested in surgical utilization have concentrated their investigations on the development of concepts, and the subsequent linkage of these concepts into models of surgical utilization.

A synthesis of two models has been used to produce the conceptual model depicted in Figure 1. The macro-system view has been adapted from Andersen and Anderson's (1979) health service component model, which profiles the spectrum of health services available to the public, and provides a suitable backdrop from which to view surgical utilization. Greenhill and Haythorne's (1972) utilization model has been used to provide a micro-system perspective. This segment of the model specifies the domain of user (patient or client) and provider (physician and other health care workers) interaction, and translates this interaction into concepts of need, demand, and utilization.

The essential differences between the macro and micro perspectives are that the former encompasses large numbers of individuals, institutions, and regulating agencies, and is subject to complex decision-making strategies; the latter functions with fewer individuals, is not necessarily dependent upon the presence of a health facility, is subject to fewer regulatory influences, and is characterized by decisions that usually involve two parties, the physician and the client. It should, however, be recognized that the micro and macro elements that combine to form the conceptual model must necessarily interact in order for surgical utilization to occur. The following two sub-sections delineate the perspective adopted in this study, and elucidate the macro and micro components of the conceptual model.

Figure 1

Conceptual Model of Surgical Utilization



Source: Macro-system Perspective adapted from Andersen & Anderson, 1979.
Micro-system Perspective adapted from Greenhill & Haythorne, 1972, p. 11.

2.1.1 Macro-System Perspective

The utilization of health services that traditionally occurs throughout Canada has been summarily depicted as the macro-system perspective in the upper half of Figure 1. The model has not been designed to reflect the relative size or importance of the service divisions, as the intent was only to introduce the gamut of health services available to the Canadian public, and to demonstrate the niche of surgical utilization within this service spectrum.

Andersen and Anderson (1979) divided the health service spectrum into two discrete, though mutually dependent, categories: public and personal services. While personal services comprised the larger of the two categories, the salient distinguishing feature between the categories is that:

> the former services can be carried out with only the passive participation of the population, without its knowledge, or even - if necessary - with enforced compliance; while the latter service must be initiated by individuals. (Andersen & Anderson, p. 372)

Examples of public services include public sanitation and inoculation programs, and the programs designed to protect the population from impure water, food, and air (Aaron, 1980).

The author has adapted Andersen and Anderson's (1979) typology of use by condensing the original seven categories which defined personal service utilization into two categories which are referenced to service location:

hospital services, and all other personal services. Both categories of service are involved with the dispensation of some common services. Typically, hospital services include those services provided by physicians, nurses, allied health personnel, dentists, and ancillary service personnel. The presence or absence of these services in any one hospital will depend upon the hospital's designated function, economic exigencies, and other factors. The "other" category of personal services includes the use of the aforementioned services in non-hospital service settings, as well as the services provided by homeopaths, faith healers, folk practitioners, and others not customarily regarded as members of the scientific medical community (Andersen & Anderson, 1979).

Hospital services have been divided into surgical services and all other hospital services. Surgical services include not only the personnel who perform surgery and care for the surgical patient, but also those individuals and institutional attributes that facilitate the functioning of the surgical suites and the necessary auxillary services. Included within the "other" hospital services category are the myriad of services available in Canadian hospitals. This service continuum includes the traditional medical, obstetrical, diagnostic, psychiatric, and laboratory services, and the more recent expansions into education, counselling, and social welfare programming.

The previous discussion summarized the elements which comprise the health service system, and demonstrated that surgical utilization is one small element in the health service spectrum. In the following section the concept of surgical utilization is explored using the perspective of patient/physician interaction. This approach should facilitate an awareness of the service being investigated, and an understanding of the process by which surgical utilization occurs.

2.1.2 Micro-System Perspective

Greenhill and Haythorne's (1972) conceptual model of health care utilization has been minimally adapted to reflect surgical utilization while retaining the model's inherent clarification of the need, demand, and utilization relationship. Initially, symptoms with and without accepted surgical treatment have been used to establish the universe of surgical symptom complexes in the population (Greenhill & Haythorne, 1972). With each subsequent level (level two to four) the model illustrates need, demand, and utilization respectively. (further discussion of these concepts can be found in section 2.1.3)

Implicit within the model is the concept that the need and demand expressed by either patients or physicians have "true" and "false" components. This designation is a function of the interaction among medical, social, psychological, economic, and political determinants.

Logically, if the screening mechanisms for surgical treatment were perfectly accurate, those persons with medical symptoms for which there was no accepted surgical treatment would never undergo surgery. However, reality dictates that some of the persons with "false" surgical need will interact with the surgical service system. Their "false" needs will be expressed and met, and contribute an unknown proportion of data to the total surgical utilization statistics.

The opposite half of the model indicates the course that those with "true" surgical needs may follow. Their "true" surgical needs may be both expressed and met. Some proportion of "true" need will go unnoticed, resulting in unperceived need. Additionally, not all "true" needs will be expressed, and some proportion of expressed need will not be met.

Proceeding vertically upward through the model it is evident that there is a gradual decrease in the number of persons with potential for actually receiving surgical care. While the reduction in numbers is conceptually sound, the actual quantification of this decrease was impossible to incorporate into the model, as need is extremely difficult to measure. Elaboration concerning need, demand, and utilization has been provided in the following paragraphs, as these concepts are particularly pertinent to this study.

2.1.3 Need, Demand, and Utilization

The literature is replete with conflicting definitions regarding the concepts of need, demand, and utilization. Kalimo (1979, p. 64) has operationally defined need as "the difference between observed and ideal levels of health." The ambiguity inherent in this type of definition prompted the economist Fuchs (1968) to remark that the concept of need was too imprecise to be of value for analytic purposes. However, researchers have persisted in trying to define and measure need, cognizant that need appears to be a relative rather than absolute concept (Cooper, 1974), and recognizing that typically the health care planners' mandate was to forecast and plan for the needs of the entire population and not simply those who used medical services (Kalimo,1979; MacStravic, 1978).

Two contrasting normative concepts reflecting the consumer's and medical profession's perspective have characterized definitions of need. Ohmura (1978) conceptualized need as a state perceived by the individual that occurred once a person had decided that medical consultation was necessary. Manifested care-seeking behavior was, therefore, seen as evidence of perceived need. Alternatively, Jeffers, Bognanno and Bartlett (1971) termed these patient perceptions "wants" and defined need in terms of medical opinion that determined those patient demands "deemed to require attention by a medical expert" (Cooper, 1974, p. 91). At a macro-level, incidence and prevalence rates are often used to describe medically-defined need (Kalimo, 1979).

Parallel to these dichotomous need definitions, "demand" has been used to describe a person approaching the medical establishment soliciting care (Boulding, 1966; Cooper, 1974), and alternatively, as the use of medical resources that occurs once the physician has initiated a care plan (Ohmura, 1978). In contrast, Feldstein's (1966) analytic framework merges these two orientations and provides for "initial" demand by the patient, followed by "derived" demand which arises as a consequence of physician action. Boulding (1966, p. 7) has stated that once a patient "puts himself into the hands of the professional, demand disappears and no substitute exists for trust in the professional's concept of need."

In Canada, federal and provincial legislation specifies that physicians must determine whether or not a person's health status warrants medical intervention. Utilization can therefore be viewed as the consequence of the medical professional's affirmation of the patient's perceived need, and the subsequent interaction between available medical resources and the resources requested by the physician. However, in the literature, references to demand and utilization are frequently confused.

For the purposes of this study, Figure 1 (the conceptual model) has been used to clarify the relationship between need, demand, and utilization. The model accounts for both the patient's and the physician's need and demand perspectives. Further clarification of the relationship between demand and utilization is provided in the following section which briefly outlines supply/demand analysis.

2.1.4 Supply/Demand Analysis

The impetus for supply/demand analysis of the medical marketplace has arisen out of a need to understand the mechanisms responsible for increasing rates of utilization and the associated costs, usage variations, and from a desire to forecast effectively (Feldstein, 1966). Research on the factors influencing supply and demand, and supply/demand interaction, has been hampered by two problems. First, researchers have frequently failed to distinguish between demand and utilization. (see for example: Guzick, 1978; Klarman, 1965). Stoddart and Barer (1980) have succinctly summarized this confusion:

> When demand equations consist of a measure of utilization regressed upon a set of independent variables reflecting prices and consumer characteristics, either the assumption of no supplier inducement is being made (usually implicitly), or the empirical formulation would appear to be misspecified. (1980, p. 153; emphasis added)

Specification of utilization equations should involve both supply and demand variables, and demand should be recognized as consisting of a "patient-initiated" stage and a "physician-generated" stage (Stoddard & Barer, 1980). Clearly the implications for policy development are quite varied if information is based on the analysis of utilization equations with limited or inappropriate variables.

The second problem has arisen with attempts to investigate the effects of supply and demand in the medical marketplace while employing the standard concept of consumer sovereignty (Cullis & West, 1979). Conventional economic analysis is predicated on the independence of consumer (demand-side) and supplier (supply-side) behavior. At issue is the nature of consumer and supplier behavior. Due to a certain degree of ignorance, the consumer is obliged to largely abdicate his decision-making role with regard to choosing appropriate medical services, and to delegate this responsibility to the physician. The perception of the patient's diminished decision-making role has led to hypotheses concerning "physician or supplier inducement", "demand-shift", and "imperfections in the agency relationship between the physician and client" (Evans, 1974; Fuchs, 1978; Wilensky & Rossiter, 1980). Additionally, legislation that restricts competition among physicians and other health care providers, the medical profession's restriction on the supply of practitioners, as well as their code of ethics which prohibit explicit price competition, have meant that consumers are unable to choose alternate services or to easily compare services (Gabel & Redisch, 1979).

The consensus expressed in the literature indicates that with the removal of most financial barriers (a consequence of the initiation of provincial medical and hospital insurance plans), and the lack of independence between the consumer (patient) and the supplier (physician), no generally accepted economic theory of supply/demand for the medical marketplace exists. An array of divergent models have emerged, reflecting various theoretical perceptions of consumer and provider behavior. Evans (1974) has proposed a general target model that appears to account for much of the behavior observed in the Canadian medical marketplace. Implicit within the model are the assumptions that: 1) the physician is motivated to achieve a target income and workload, and 2) the constraints imposed by fee-schedules can be circumvented with extra-billing options and renegotiation of the fee schedule. The policy implications regarding methods for the deceleration of increasing medical costs, that emanate from Evans' model, are diametrically opposite to those implied by the traditional model. The target model predicts that expanded physician supply and the imposition of deterrent charges will increase utilization of service (which introduces the potential for over-utilization of services), while the traditional model predicts that the same conditions will result in decreased utilization.

The demand for rational health care policies which provide appropriate incentives to both consumers and suppliers, emphasizes the need to: 1) engage in research that clearly distinguishes the factors associated with demand and utilization, and 2) construct models that accurately reflect the consumer and provider behaviors witnessed in the medical marketplace.

2.1.5 Summary

Delineation of the interaction between patients, physicians, and the health care service system was portrayed in a conceptual model of surgical utilization. Explanations regarding the macro and micro components illustrated the ambiguity associated with the concepts of need, demand, and utilization, and demonstrated the complexity of the relationship between supply and demand for surgical services. This conceptual framework is used in subsequent sections of the literature review as the basis for examining the determinants of surgical utilization, and as background information for the section concerning selected aspects of surgical utilization.

2.2 Determinants of Surgical Utilization

Andersen and Newman's (1973) theoretical framework, which closely parallels the components of the conceptual model (cf. p. 12), has been used to categorize the literature concerning the determinants of surgical utilization. Three types of determinants have been considered: 1) societal, 2) individual, and 3) health service system. For ease of discussion and clarity, the determinants have been discussed separately; however, it should be recognized that the effect of a particular determinant rarely occurs in isolation, and further, interaction effects among determinants are poorly understood.

It is not the intent of the author to provide an indepth review of these determinants; rather, aspects pertinent to this study have been discussed. Additionally, not all of the references cited pertain specifically to surgical utilization as such literature was scarce.

2.2.1 Societal Determinants

Norms and changing technology are the main societal determinants deemed responsible for increased health service use, as changing levels of disease incidence are unlikely to be primary contributory factors to this increase (Andersen & Newman, 1973). Norms that identified health care as a right (Andersen & Anderson, 1979) facilitated the enactment of legislation that specified that the cost of the majority of hospital, physician, and certain other health services be financed through provincial insurance plans (see the Hospital Insurance and Diagnostic Services Act, 1957, and the Medical Care Act, 1966). LeClair (1975) commented that although there was an initial accelerated amount of utilization of all health services by Canadians following the passage of these Acts, the increase had since moderated.

Analogous effects of increased health services insurance coverage have been observed in the United States (Mechanic, 1979).

The medical profession's desire to preserve the integrity of the client/physician relationship has meant that the profession staunchly supports the fee-for-service norm as the preferred mechanism of physician reimbursement. Evans (1974) and others alleged that the fee-for-service method of payment provided no incentive for either the patient or the physician to control costs, and as such, had contributed to escalating costs and utilization rates. Unfortunately, norms that specify appropriate levels of surgical utilization are not available to assist planners in determining the amount of under or over utilization of services (Bice, Eichhorn & Fox, 1972).

Another important norm concerns the rationing of health care services. Mechanic (1978) and Cooper (1974) indicated that, although the norm to ration medical services had always been present due to the reality of scarce resource limitations, cost containment concerns had prompted evaluation of the implicit rationing process (where constraints inherent in the system serve as the rationing mechanism). An increasing emphasis on explicit rationing processes, which involve direct decisions regarding allocations of the type and amount of service to be offered, are likely to be combined with implicit rationing mechanisms (Mechanic, 1978). The effect of the rationing process on surgical utilization is unknown; however, both the volume and type of surgical procedures performed may be influenced.

Norms which influence the decision-making process of physicians have also been associated with increased utilization of health services. Using a statistical metaphor, Gertman (1974) and Scheff (1963) indicated that the decision norm of the medical profession was to avoid committing Type I errors (mistakenly not treating a sick person) as opposed to Type II errors (mistakenly treating a well person), and therefore, the tendency was toward increased utilization. Type II errors of a surgical nature are responsible for substantial risks being needlessly incurred by patients, as well as increased morbidity and mortality rates. Patients who have been inappropriately labelled as a consequence of a Type II error occasionally experienced psychomatic disability, which also contributed to increased health services utilization (Bergmann & Stamm, 1967). Similarly, while the physician seeks to avoid the medical profession's sanction associated with Type I errors, he is also concerned about the malpractice threat. The practice of defensive medicine (where tests and/or procedures are performed largely because the physician fears malpractice litigation) has been implicated as a factor contributing to increased utilization of health services (Stuart & Stockton, 1973). The extent to which defensive medical practices influence utilization is not known; however, the Duke Law Journal staff (1971) indicated that positive defensive practices (the ordering of numerous tests etc.) and negative defensive practices (the inhibition to use new technological innovations) are differentially affected by the malpractice threat. In Canada, the presence of the malpractice threat is negligible compared to that experienced in the United States (Kreever, 1975); therefore, the alteration of Canadian physicians' practice patterns in response to this threat is likely to be minimal.

The last societal determinant to be discussed concerns technology. The impact of changing technology on the utilization of health services has been well documented (see Bronzino, 1977; Reiser, 1978; Russell, 1976). The introduction of anaesthesia and asepsis altered patterns of care in hospitals, and simultaneously changed the custodial orientation of the hospital to a curative focus which resulted in dramatic increases in both hospital and surgical utilization (Andersen & Newman, 1973). While Gertman and Mitchell (1980, p. 881) attributed increased surgical utilization rates in part to the development of medical technologies "that permit earlier and more efficacious intervention for more individuals," Fuchs (1968) cited a technologic imperative as the prime factor guiding the physician's use of services. Quite simply, physicians feel compelled to give the "best care that is technically possible; the only legitimate and explicitly recognized constraint is the state of the art" (Fuchs, p. 192). Rutkow and Zuidema (1981) noted the increased rate of Caesarian sections associated with increased use of fetal monitoring techniques as one example of the technological imperative.

Bennett (1977) identified an important difference between the factors that induce technological change in the medical arena, and those that operate in the business sector. While consumer demand is the primary impetus for technological innovation in business, the decision-making role of the physician and medical insurance plans effectively remove the consumer from a decision-making capacity in the medical marketplace. The consequence is that monetary limitations are not imposed on technological innovation through consumer demand, and thus one of the reins on cost control is removed.

This lack of consumer control over technological innovation combined with the physician's technological imperative, has resulted in what Thomas (1977) described as "half-way" technologies. Half-way technologies developed for palliation or control of symptoms (for example, renal dialysis), tend to be more numerous and expensive than their counterpart, definitive technologies, which offer cure or repair (Thomas, 1977). Bennett (1977) noted a similar distinction between "add-on" and "substitute" technologies. Add-on technologies provide additional support to already existing techniques, whereas substitute technologies effectively replace outmoded techniques. The impact of add-on technologies on the cost and utilization of all medical services can be substantial, as acute care utilization may be increased, and the prolongation of life may lead to increased chronic care costs.

From the preceding review it is apparent that both normative influences and technological change possess significant potential to alter the patterns of utilization of all health services. It is also evident that measurement of these influences is very complex, and as yet, has largely eluded researchers.

2.2.2 Individual Determinants

An interest in the characteristics of individuals which may affect patterns of health service utilization has been reflected by the large number of studies concerning individual determinants. In addition, comprehensive literature reviews (Anderson, 1973; McKinlay, 1972) and an extensive bibliography (Aday & Eichhorn, 1972) have been written. Since individual determinants of surgical utilization vary according to the type of surgery considered, and since the majority of research dealt with health service utilization rather than surgical utilization, discussion of the individual determinants of surgical utilization has been limited to a review of the approaches used and some pertinent methodological considerations.

In the majority of studies concerning individual determinants, researchers employed a singular focus, and variable selection has been a function of the perspective or research strategy used. Economic, socio-demographic, geographic, social/psychological, and social systems approaches have been used in addition to disease incidence study approaches. Some researchers constructed models of utilization in an attempt to provide logical organization to a number of selected determinants. Bice and White (1971, p. 261) cited Feldstein's (1966) demand model of medical care utilization as the most comprehensive model currently available, because it "gives the concept of choice among alternative services a prominent role and explicitly recognizes the joint influences of patients' and providers' characteristics in shaping courses of treatment." Less inclusive models include Andersen's (1968) predisposing, enabling, need model, and Rosenstock's (1966) socio-psychological health behavior model.

Conflicting conclusions with regard to the relationship between individual determinants and actual utilization patterns characterize these studies, and have limited this discussion of individual determinants of surgical utilization. Aday and Eichhorn (1972) indicated that the normal cleansing process that occurs in evolving literature bases had not happened because of the volume of confounding evidence. The prevalence of contradictory conclusions has been attributed to varying conceptualizations of relevant issues, and to significant methodological differences that make comparisons among studies difficult (Mechanic, 1979). McKinlay (1972) agreed with this view, and suggested that comparisons between different medical care systems had also proven problematic.

Inappropriate research designs often compromised the usefulness of study results; four basic problems have been outlined. First, researchers formulating their research plans frequently failed to remain cognizant that different determinants are associated with: 1) different types of service provision (hospital, dentist, etc.), 2) the purpose of the service (primary, secondary, tertiary, or custodial care), and 3) the unit of analysis (total volume of services received, initial contact with the physician, etc.) (Andersen & Newman, 1973). Second, although researchers often recognized the limited applicability of studies that did not include interaction effects, very few multi-variate studies have been done (Bice & White, 1971; McKinlay, 1972). Third, researchers often designed their projects so that persons who displayed characteristics similar to the study group, but who did not demonstrate the same utilization behavior, were excluded from the investigation (McKinlay, 1972). Finally, Rosenstock (1966) stressed that if one is interested in changing utilization patterns, it is necessary to realize that studies that investigate how people use services do not necessarily indicate why people use them.

Despite the volume of literature, and the duration of time that this topic has been studied, the aforementioned problems have meant that research results are primarily descriptive in nature rather than explanatory. It is important to realize that many of the individual determinants (age, sex, race, etc.) are not mutable, and therefore, continued investigation of the causal association between individual determinants and utilization, while assisting forecasters, will be of little value to those trying to influence utilization patterns.

Utilization studies have concentrated on the characteristics of individuals accessing the health service system, rather than incorporating the health service system's characteristics as possible determinants. Ultimately, researchers will likely discover that, models that account for the complex interactions between prospective patients and the health care system will provide a more accurate indication of the determinants of health service utilization.

2.2.3 Health Service System Determinants

In this section, a brief introduction to some of the health service system determinants is provided. It is beyond the scope of this thesis to outline all of the variables and their interactions; therefore, only two aspects, resources and organizational elements, will be reviewed.

Resource Determinants

The total volume of resources (labor and capital) and the pattern of resource distribution have been postulated as important determinants of use. The positive relationship between volume of resources and observed use is well known. As early as 1959 Shain and Roemer stated, "hospital beds that are built tend to be used" (p. 71). Surgical applications of this phenomenon, which reflect the positive relationship between the surgical resources in an area and the surgical utilization rate, have been documented in several studies (Bunker, 1970; Fuchs, 1978; Harris, 1975; Lewis, 1969; Stockwell & Vayda, 1979). However, Roos, Roos and Henteleff (1977) and Rutkow and Zuidema (1981) using sophisticated methodologies, were unable to document a correlation between surgical resource availability and use.

Speculation regarding the resource-sensitive nature of surgical utilization led some observers to suggest that surgeons were able to generate demand for their own services, and as such, raised questions concerning quality of care. However, as Andersen and Newman (1973) stressed, proponents of the "demand generation theory" necessarily assume that resource availability is the sole contributory influence to increasing surgical utilization, and that other system variables are constant over time - a rather simplistic assumption. Alternatively, the association between resource availability and use may reflect the proclivity of patients in need of surgery to locate surgical resources (Blackstone, 1974).

Despite the dominant role of the physician as the primary allocator of medical resources (both his own, and others through referral practices), little research has been done investigating the rationale behind the physician's decisions regarding service provision (Gertman, 1974). This type of research would seem to be especially important given Evans' (1975) assertion that 80% of all health care expenditures are attributable to physician behavior.

Physician/population ratios, and bed (or surgical suite)/population ratios do not communicate the important aspect of geographic distribution of resources. Although geographic proximity is frequently cited as an important determinant of use, the nature of this relationship is not clear. Studnicki (1975) found that although obstetrical patients tended to minimize travel distance for hospital admission, distance was not necessarily the most important determinant influencing the patient's choice of care facility. McKinlay's (1970) research in Scotland demonstrated that certain people consistently underutilized service, despite their close location to a care facility. In many rural areas, a lack of surgical resources may prevent people from seeking care in the facility closest to their residence. The patient's perception of the necessity of obtaining surgical care, combined with the influence of the physician's referral practices, may determine the facility used regardless of its location.

One geographic issue pertinent to surgery, which has arisen due to cost and quality of care issues, concerns the regionalization of surgical services. Luft, Bunker, and Enthoven (1979) investigated mortality rates for twelve surgical procedures to determine the relationship between surgical volume and surgical mortality. These researchers proposed regionalization for certain operations since their results indicated that "the quality of care improves with the experience of those providing it" (Luft, Bunker & Enthoven, p. 1364). In a later article, Luft (1980, p. 940) warned that although the "strong negative curvilinear relationship between the volume of a particular operation and post-operative mortality" was confirmed, identification of causal factors was very difficult. Luft was unable to determine whether or not higher volumes led to a better outcome, or better outcomes led to a higher volume. Alteration of established travel patterns would be inherent to any plan to regionalize surgical resources, and therefore, further investigation would be necessary prior to the implementation of a plan to regionalize surgical resources.

Organizational Determinants

Organizational determinants are those influences on utilization behavior that arise as a consequence of the manner in which resources are used to provide a service. The organizational determinants considered pertinent to this study include organizational characteristics which influence the patient's ability to access the health care system, and the organizational mechanisms that determine the patient's care experience following entry to the system (Andersen & Newman, 1973). As mentioned previously, interaction effects among determinant variables, though infrequently studied, are very important. Accessibility to the system is in part a consequence of the particular structural orientation of the system, which is essentially dependent upon resource type and availability. An indepth exploration of access and structural variables and their interactions was beyond the scope of this review; therefore, only two organizational determinants, access barriers and structural and bureaucratic factors, are discussed.

Access Barriers Berkanovic, Telesky, and Reeder (1981, p. 694) studying utilization of medical care in the U.S. indicated that a regular source of care and the ability to pay for medical service were "consistent predictors of the use of physician services." In Canada, the introduction of the hospital and medical insurance plans (see the Hospital Insurance and Diagnostic Services Act, 1957, and the Medical Care Act, 1966) were intended to largely eliminate financial barriers which would inhibit access to health care services. As such, one of the stipulations incorporated into these Acts, involved restrictions on the direct charges to patients levied by those responsible for the administration of provincial insurance plans. Current concern regarding the effects of extra or balance billing (where the patient is charged a fee in addition to the amount paid to the physician by the insurance plan) has focussed on the detrimental influence such practices may have on access to health care services. While removal of financial barriers is an important access variable, Marmor and Tenner (1977) emphasized that equal accessibility cannot be equated with equal use due to the multidimensional nature of access.

Queue lengths and differential acceptance of patients according to disease or disability are other variables thought to influence access to service (Andersen & Newman, 1973). The importance of the above factors in relation to surgical utilization is poorly understood as the majority of studies have not researched surgical utilization specifically.

Structural and Bureaucratic Factors Observed differences in utilization rates among different countries prompted investigation of the structures used to deliver health services. Researchers that perceived utilization to be a function of a particular structure have focussed on the alteration of the existing structure as one method of influencing utilization patterns. As such, it has been suggested that the method of payment and the associated structural mechanisms have a substantial influence on the number of operations performed (LoGerfo, 1977; LoGerfo, Efird & Diehr, 1979; Perrott, 1966). Cross-national comparative research implies that similar observations are made in different countries. However, the presence of numerous intervening variables unique to different cultural systems has made true comparisons between countries difficult, and has also made it difficult to predict the possible implications of changing the health service delivery structure in a particular country.

In Canada and the U.S. the majority of physicians are paid under a fee-for-service system, where the physician is paid according to the amount of work performed, with the level of remuneration in accordance with an established fee schedule. Salary and capitation are the two common alternative payment methods. Under salary arrangements, the physician is paid for a specified time period, regardless of the amount of service given to patients, while capitation payments are based on the number of persons enrolled, not the amount of service delivered. These different remuneration mechanisms provide various incentives for the use of services. Gabel and Redisch (1979, p. 47) noted that:

> Although it may be easier to support empirically the hypothesis that fee-for-service leads to higher utilization levels than salary or capitation, it is more difficult to determine if there are too many operations, x-rays, and laboratory tests under fee-for-service, or too few under capitation or salary.

With regard to bureaucratic factors, both McKinlay (1972) and Anderson (1973) reviewed studies that attempted to isolate structural and bureaucratic factors that influenced: 1) the professional's behavior toward clients, 2) the interaction between professionals and clients, and 3) the structural characteristics that inhibited use by certain socioeconomic groups. It is noteworthy that such research is concerned with organizational attributes that impede those in need of service, rather than organizational features that promote or facilitate utilization.

2.2.4 Summary

The societal, individual, and health service system determinants thought to influence surgical utilization were reviewed in order to demonstrate the large number of possible determinants, and the complexity of their interactions. Two significant problems have compromised attainment of a comprehensive understanding of the relationship between various determinants and the patterns of surgical utilization. First, the focus of many researchers on individual determinants has resulted in a lack of awareness of both alternative variables and interactions of variables. Second, obtaining reliable data, and determining valid measurements of the effects of either singular variables or interactions of variables has been fraught with problems arising from inadequate research methodologies. In summary, only fragmentary concepts and models exist to assist in the explanation of the determinants of surgical utilization.

2.3 Selected Aspects of Surgical Utilization

Increased rates of surgical utilization, and variable rates of surgical use among similar geographic areas, prompted some observers to question the appropriateness of the level of surgical utilization being experienced. Variation is suggestive of either over or under utilization, and therefore, cost and quality of care concerns are paramount. Guided by these concerns, researchers tried to determine the surgical needs of the population and compare them to the surgical resources actually used.

In this section, literature pertaining to: 1) the concept of unnecessary surgery, 2) surgical rates in Canada, and 3) surgical indices is reviewed.

2.3.1 Concept of Unnecessary Surgery

Unnecessary surgery, though lacking a precise definition, has been frequently advanced as a reason for surgical utilization rate variation. The purpose of this section is to demonstrate the complexity of the concept of unnecessary surgery through a discussion concerning its definition and measurement.

Definitions of Unnecessary Surgery The inexactitude of medical practice was acknowledged by Mosteller (1978, p. 185) who indicated that avoidance of all unnecessary surgery would require "perfect diagnosis and perfect knowledge of the course of the disease and the effect of surgery." In an earlier article, Cope (1965) suggested that some unnecessary surgery was inevitable due to time constraints, the inability to keep abreast of emerging techniques that replaced older ones, as well as the surgeon's reluctance to abandon conventional approaches. The subjectivity inherent in decisions concerning clinical decisions and treatment has meant that the normative concept of unnecessary surgery remains without a generally accepted definition. Three tentative definitions have been discussed in order to illustrate prevalent perspectives, and to demonstrate the difficulty in stating an inclusive definition.

The authors of the Study of Surgical Services for the United States (SOSSUS) indicated that there "are variations in degree of necessity, whether medical, personal, or social" and outlined six types of operations that could be termed unnecessary "depending upon their individual clinical frame of reference":

> a. Operations where no pathological tissue is removed;
> b. Operations whose indications are a matter of judgement;
> c. Operations to alleviate endurable or tolerable symptoms;
> d. Discretionary operations for asymptomatic, non-pathologic, or non-threatening disorders;
> e. Operations now outdated, obsolete, or discredited; and
> f. Operations for which there is little justification by clinical, x-ray, or laboratory study. (SOSSUS, 1975, p. 89, 90)

The latter two categories would likely produce minimal controversy; however, the first four categories are not as likely to produce agreement given the inexplicit nature of the criteria, and the subjectivity of clinical decision-making.

Annas (1979) and Crile (1978) called for total abandonment of the term unnecessary due to its ambiguous nature. Annas (p. 14) inferred that the term was a pseudonym which masked the real issues of "quality control . . . cost control, and patient access to information." Crile's rationale for rejection centered on the inability of the term to reflect the numerous reasons for which operations are performed (e.g., for survival, comfort, safety, birth-control). Crile suggested that the terms "appropriate" and "inappropriate" be used, and delineated three categories of inappropriate surgery:

> a. Operations in which the surgery was not an appropriate treatment for the disease;
> b. Instances where an operation, or the type of operation chosen, was not appropriate for the individual; and
> c. Operations which are performed by a surgeon not trained to perform the operation expertly. (p. 136-138)

Unfortunately, these categories do little to delineate explicit criteria that would be minimally influenced by subjective opinion. Pauly (1979) and Stuart and Stockton (1973) indicated that appropriateness embodied both socioeconomic and medical factors. Pauly defined unnecessary surgery as a function of costs and benefits, stating "a procedure is defined as unnecessary if expected benefits fall short of expected costs" (p. 97). This succinct definition conceals a number of problems. The valuation of all costs and benefits, especially those associated with years of life gained or lost, has proven very difficult (Bunker, Barnes & Mosteller, 1977). Additionally, Mosteller (1978) stressed that conflicting objectives concerning the minimization of deaths, convalescent days, and normal tissue removal, presented a dilemma, as no one decision that could satisfy all of these demands was available for use in a cost/benefit analysis.

Central to the issue of defining unnecessary surgery is the need for "more information as to the effectiveness of surgical therapies," since ineffectual therapies are obviously unnecessary (Stroman, 1979, p. 11). However, as Bunker (1970, p. 142) indicated, "the indications for surgery are sufficiently imprecise to allow a 100% variation in rates of operation," thereby making it difficult to compare the effectiveness of surgical treatment to other forms of treatment. Szasz and Hollender (1956, p. 592) stressed that the treatment techniques employed by different specialists (e.g., internists, surgeons, psychologists) could logically be compared only if one was reasonably sure that the "interventions are based on the same frame of reference," that is, a common conception of the underlying disease process and expected outcome of treatment.

Evaluation of the efficacy of different surgical procedures has also been difficult due to the lack of consensus with regard to the indications for surgery, and the absence of routine randomized clinical trials (LoGerfo, 1977; Mosteller, 1978). Ethical reasons have frequently prevented the initiation of clinical trials subsequent to the implementation of a surgical technique. For example, the morbidity and mortality associated with not removing an acute appendix prevent random assignment of such a case to a non-operative group during a clinical trial of appendectomies (Ryan, 1979).

From the previous discussion it is apparent that, due to an absence of accepted standards concerning the indications for surgery, a definitive meaning has yet to be affixed to the concept of unnecessary surgery. Consequently, the validity of using this term as an explanation for surgical utilization rate variation has been compromised. Despite the absence of a precise definition, researchers have tried to assess the level of unnecessary surgery. A selection of the methods used to measure this concept are discussed below.

Measurement of Unnecessary Surgery Tissue committees, peer review, and retrospective chart review programs are three methods commonly used to assess surgical utilization. The validity of the latter two, which usually rely on information contained in the medical record, is questionable, since there is little evidence to indicate that the medical chart is a valid reflection of the circumstances of a particular case. Similarly, criteria used to evaluate medical records should be validated prior to their use. Rutkow, Gittelsohn, and Zuidema (1979) demonstrated a marked divergence of opinion among surgeons who were asked to evaluate seven case studies and judge whether or not surgery was warranted. deRouville (1971) documented substantial intra and inter-reviewer variation among twenty surgeons asked to review a selection of medical charts, and concluded that the surgeons lacked the reviewer-expertise necessary to complete an accurate chart review. In view of these findings, it appears that measurement of the level of unnecessary surgery using medical chart review processes is inadvisable.

Utilizing a different perspective, some researchers assumed that surgical second opinion programs could be used to indicate the degree of unnecessary surgery. The rationale supporting this perspective originated with a study by McCarthy and Widmer (1974) who indicated that, if patients were asked to obtain a second opinion after having initially been advised to have surgery, and the initial opinion was not confirmed, then patients would not undergo surgery and unnecessary elective surgery would be avoided. Thus, after the institution of a surgical second opinion program for a group of union members in the U.S., the number of unnecessary surgeries theoretically prevented was calculated to be the number of people not confirmed for surgery (approximately 24% of all patients initially seen). Rutkow and Zuidema (1978) and Emerson and Creedon (1977) as well as many others, took strong exception to the illogical premise that a difference of opinion among experts supported a conclusion of unnecessary surgery. Additionally, Brook and Lohr (1982) indicated that while proponents of surgical second opinion programs extolled the cost-saving benefits that accrued due to the reduced number of surgical cases, little was known about those who did not undergo surgery. Since people not confirmed for surgery were not assessed further, it was impossible to tell if the program reduced both necessary and unnecessary surgery.

The limitations of the McCarthy and Widmer (1974) study were apparently missed by the Subcommittee of Oversight and Investigation (1976) in the U.S. who compounded the original errors of the study by generalizing the results pertaining to the level of unnecessary surgery to the entire U.S. population. The members of this committee stated that 11,900 needless deaths had occurred during the performance of 2.4 million unnecessary surgeries. These statements and the associated press releases instilled greater public awareness concerning the issue of unnecessary surgery, and fostered the impression that the concept was easily quantifiable (Emerson & Creedon, 1977; Rutkow & Zuidema, 1981).

The unnecessary surgery debate was also stimulated by researchers who stated that steadily increasing per capita surgical rates were indicative of the performance of unnecessary surgical procedures. McCarthy and Finkel (1980) reported a 34% increase in the number of surgeries performed in the U.S. between 1971 and 1977, and insinuated that the increase was due to excessive surgical resources being utilized. Similar allegations concerning the influence of manpower availability had been made previously (see Nickerson, Colton, & Peterson, 1976a, 1976b, and SOSSUS, 1975). Rutkow and Zuidema (1981) challenged the conclusions of the McCarthy and Finkel study, and demonstrated that when the data from 1966 to 1978 were age and sex-standardized, a

26% increase in surgical rates was evident, and more importantly, the majority of the increase (24%) had occurred between 1966 and 1974. It is necessary to age and sex-standardize data in order to remove the effect of age or sex as an explanatory factor for the differences observed over time or between regions, and McCarthy and Finkel had not adjusted their data.

Rutkow and Zuidema (1981) showed that in four of the seven major surgical categories studied (general surgery, urology, gynecology, and otorhinolaryngology), a decrease in surgical utilization had occurred. Thus they concluded that: 1) a sustained increase in surgical utilization rates did not characterize the surgical experience of the U.S. population, 2) a five-year plateau in the increase in rates had been observed from 1974 to 1978, and 3) a correlation between the number of operations performed and the availability of surgical manpower had not been demonstrated. Thus, "the belief that surgical utilization rates will inevitably rise as the total number of surgeons increase" was not supported in the study (Rutkow & Zuidema, p. 161).

Utilizing an investigatory perspective, rather than presupposing the existence of unnecessary surgery, Roos, Roos and Henteleff (1977) used Manitoba utilization data to examine the relationship between elective surgical utilization rates, and the degree to which specified criteria for selected surgical operations had been met. It was expected that higher surgical rates might be associated with surgeons not meeting the specified criteria. However, these researchers did not find significant correlations, and Roos et al. stated "this research underlines the complexity of physician practice patterns and challenges the simplistic assumption that high elective surgical rates indicate lowered standards of practice" (p. 364). An additional finding by this group regarding the degree to which most physicians infrequently met the established criteria for performing the selected operations generated concern. LoGerfo (1977, p. 388) stated "there is no question that factors other than simple clinical status go into such a decision," but the Roos et al. study indicates that "other factors may be more important than the clinical state of the patient." This perplexing finding obviously requires further investigation.

During the last two decades, marked variation in the surgical rates among similar geographic areas has also been used by some researchers as evidence of unnecessary surgery. However, Mosteller (1978) suggested that the observed variation may simply reflect different effective practice patterns. Substantial variation has been observed among countries (Bunker, 1970; Pearson, Smedby & Berfenstam, 1968; Vayda, 1973), and among smaller areas such as provinces, states, or counties (Lewis, 1969; Stockwell & Vayda, 1979; Vayda, Lyons, & Anderson, 1977; Vayda, Morison & Anderson, 1976; Wennberg & Gittelsohn, 1973, 1982). Evaluation and comparison of these studies is difficult, as frequently the data have not been age/sex adjusted. Additionally, researchers investigating the phenomenon of surgical utilization rate variation have had difficulty establishing comparable rates of utilization, as the rates have been based upon the location of surgical service provision, rather than on a pre-defined population base. The inherent limitation of such studies is that the number of practicing physicians and the availability of surgical suites will likely influence the surgical service utilization emanating from a particular hospital and make comparisons suspect. Additionally, the denominators used in many rate estimations have not corresponded to the population to which the patients utilizing service belong. The problem of estimating appropriate denominators has been primarily due to patient movement across geographic boundaries and the problem of establishing service areas for study hospitals.

Despite the obvious confusion surrounding the measurement of a concept that has yet to be defined, assessment of the degree to which unnecessary surgery exists remains an important quality of care concern. The preceding discussion indicates that "it is important that one does not make subjective value judgements concerning operative rates without careful study of the methods used to obtain the data and the variables under examination" (Rutkow, Gittelsohn & Zuidema, 1979, p. 416).

2.3.2 Surgical Rates in Canada

In Canada the rate of surgical separations per 100,000 persons "peaked in 1973 and then declined from 1974 to 1978"; however, the percentage of total separations involving surgical procedures has risen from 50% in 1971 to 54% in 1978 (Statistics Canada, 1982, p. 15). Examination of five age categories (0-14, 15-24, 25-44, 45-64, and 65+) demonstrated that the 65+ age group had the highest rate of surgical separations per 100,000 persons for the years 1971 to 1978 inclusive, while the 0-14 age group had the lowest rate (Statistics Canada, 1982). Dobrodzicki (1978) listed the ten most frequently performed surgical procedures, and stated that in every instance the average length of stay (ALOS) had decreased significantly between 1969 and 1974. This same researcher indicated that Canadian surgical separations had increased 21% during the years 1969 to 1974.

An important conceptual issue which arises when calculating surgical rates concerns the determination of the "population at risk for organ loss" (Rutkow & Zuidema, 1981, p. 159). Persons who have had an organ removed are obviously ineligible to have the organ removed again; therefore, they should not be counted as a member of the population at risk for a particular operation in subsequent years. Determination of the proportion of persons who have lost certain organs previously cannot be easily estimated; however, the number of persons undergoing a particular operation when compared to the total population is quite small, and is not likely to unduly influence calculated rates. Additionally, when rates are being compared over time or among regions, the effect of not calculating the true population at risk is more or less cancelled out over time and across regions.

With regard to surgical rate variation, international and regional comparisons have frequently been made. For example, using age/sex standardized data for twenty-eight surgical procedures, Vayda (1973, p. 1224) compared Canada's surgical rates to that of England and Wales and found that the former had surgical rates "1.8 times greater for men and 1.6 times greater for women" than the latter. The twenty-eight procedures were grouped into five categories: elective and discretionary surgery, cancer surgery, diagnostic procedures, orthopedic surgery, and other surgery. Analyses demonstrated that: 1) elective surgical rates in Canada were about two times as high as those of England and Wales, 2) the rate of performance of diagnostic procedures was similar between countries, and 3) rates of orthopedic, cancer, and other surgery were generally higher in Canada.

Vayda and Anderson (1975) used Canadian age/sex standardized surgical data for 1968 and compared inter-provincial rates for selected surgical procedures. These researchers found substantial variation among provinces; for discretionary procedures "the highest provincial rate was approximately twice the lowest" (Vayda &

Anderson, p. 22). Additionally, the relationship between surgical resources and surgical rates was explored, and Vayda and Anderson (p. 18) concluded that "the ratio of surgical personnel to population in each province is postulated as a major determinant of the differing provincial rates."

In the following year Vayda, Morison and Anderson (1976) published a report which detailed inter-provincial comparisons of eight elective and seven non-elective procedures for the years 1968 to 1972. This report also documented significant inter-provincial variation in surgical rates. Intra-provincial surgical rate variation has also been studied in Canada (AHUC, 1981; Roos, Roos & Henteleff, 1977; Stockwell & Vayda, 1979; Vayda, Lyons & Anderson, 1977). Discussion of the rate variation associated with selected surgical procedures has been included in section 2.4.

Comparisons of surgical service utilization among regions often involves the use of such indicators as surgical separations per total separations, or surgical services per 100,000 persons. In the following paragraphs an explanation regarding the use of surgical indices is provided.

2.3.3 Surgical Utilization Indices

The term "index" has been used to refer to ratios which are derived by measuring two associated factors, and then dividing one number into the other to obtain a decimal (Kilpatrick, 1977). Indices have been used to convey information about a hospital's performance, and to highlight an institution's deviation from established norms. However, the use of indices as measures of performance is not without controversy. Researchers questioned the validity of indices intended to measure hospital performance, and speculated on the problem of integrating the unique characteristics of each hospital, such that the index was an accurate reflection of all hospitals' performance (Dalton, 1980; Ruchlin & Leveson, 1974).

In Alberta, the Alberta Indices Program was established in 1965 under the direction of the Alberta Hospital Association and the Hospitals Division of the Department of Public Health in an effort to provide a tool that would be capable of assessing aspects of efficiency and effectiveness in Alberta hospitals. Of the thirty-three indices developed, two are pertinent to surgical utilization and have, therefore, been reviewed.

Index number two is designed to reflect the surgical activity occurring in the hospital; the number of surgical procedures performed per month is used as the basis for this index. Bernatzki (1972) criticized the utility of this index from two perspectives. First, fluctuations in the numerical value of the index were assumed to be related to the utilization of manpower and supplies. This assumption is correct if one refers generally to increases or decreases in manpower and supply utilization; it becomes fallacious, however, when the index is used to reflect proportional change. Second, the index does not reflect the intensity of service offered, and therefore, costs incurred by different hospitals may not be comparable. It is reasonable to assume that the technological support and supplies necessary for an open-heart operation, and the resources required for the excision of a benign superficial tumor differ markedly, as would the associated costs.

The second index, number twenty-four, concerns the medical and surgical supplies costs per patient day. The obvious inherent limitation of this index concerns the different prices paid for supplies by hospitals, and the cost-savings associated with larger institutions buying bulk quantities. Additionally, use of this index implicitly assumes that the unit of output is the number of patient days. Given the substantial case-mix differences among hospitals, it would seem illogical to use this index as a basis for all but the most rudimentary comparisons. More meaningful comparisons might result if the supplies cost was calculated in relation to specific medical and surgical procedures.

The utility of the Alberta Indices Program, or indices developed in the future that attempt to assess effectiveness and efficiency levels, will be dependent upon their ability to capture the essence of a diverse and complex health care system. Additional hospital indicators such as ALOS, the percentage of total separations involving surgery, and surgical separations per 100,000 persons, are commonly used to compare among hospitals, and among regions. The subsequent discussion of selected surgical procedures illustrates the use of comparative indices.

2.3.4 Summary

In this section three inter-related topics were discussed. Initially, the concept of unnecessary surgery was introduced and was shown to lack a precise definition. A preliminary review indicated the need for research approaches which investigated the nature of rate variation, not simply its presence, and for the development of statistically sound data bases.

A cursory introduction to surgical rates in Canada outlined surgical rate trends and provided evidence of substantial surgical rate variation among and within the provinces. The last section provided an explanation regarding the use of surgical indices, and demonstrated some of the problems associated with selected indices.

2.4 Selected Surgical Operations

Although a diverse set of surgical procedures are performed routinely in Canadian hospitals, only a minority are regularly reported in the literature. Typically these procedures are among those most frequently performed. Four of the six categories chosen for study were among the ten most frequently performed in Canada during 1974 (tonsillectomy and adenoidectomy, cholecystectomy, hysterectomy, and appendectomy). All six surgical categories are reviewed below in order to provide background information to which the study results can be compared.

2.4.1 Appendectomy

Appendectomy refers to a non-discretionary surgical procedure that involves removal of the appendix. In some instances the appendix is removed incidentally to other abdominal surgery, and as such, these appendectomies are categorized as discretionary.

The management of patients thought to have acute appendicitis is quite variable. Neutra (1978) indicated that two therapeutic philosophies prevailed: 1) non-interventionist, those who hoped to avoid removal of normal appendices by waiting and carefully monitoring the patient; and 2) interventionist, those who were unwilling to risk perforation of the appendix (an occurrence that is associated with high morbidity and mortality), and therefore, preferred to operate immediately, thereby risking removal of some normal appendices. However, using decision theory, Neutra (1978) suggested that improved patient assessment techniques permitted the surgeon to more accurately discriminate between those in need of an appendectomy and those with different needs. Therefore, it was possible to "reduce the rate of histologically normal appendices among operated patients without increasing the rate of perforation" (Neutra, p. 956).

In 1974, appendectomy was the seventh most frequently performed surgical procedure in Canada; however, from 1969 to 1974, the appendectomy rate declined by approximately 18% (Dobrodzicki, 1978). The most recent Statistics Canada (1982) figures for 1978 indicated that the decline has continued. Vayda and Anderson (1975) compared provincial surgical rates for 1968 and found that Alberta residents had the highest appendectomy rate for both males and females, 310 and 285 per 100,000 persons respectively. By 1978 these rates had declined to 196 and 179 per 100,000 persons for males and females respectively, lowering Alberta's ranking among the provinces to third for males and second for females.

With regard to variable surgical rates, Vayda (1973, p. 1228) indicated that appendectomy rates in Canada, England, and Wales were approximately the same, which suggested that "this disease has similar incidence, diagnostic criteria and therapeutic criteria." In a more recent study, the AHUC (1981) reported variation in appendectomy rates among thirteen regions in Alberta which ranged from a minimum of 159 per 100,000 persons, to 324 per 100,000 persons.

Thus, declining rates and variable rates of appendectomy among different regions characterize appendectomy surgery in Canada.

2.4.2 Caesarean Section

The term Caesarean section (C-S) refers to a non-discretionary surgical procedure, performed only on women, that involves the surgical removal of the fetus from the uterus in cases where the normal birthing process is not advisable or possible. In Canada, a 152% increase in the C-S rate was observed between 1968 and 1977 despite the decrease in the total number of hospital births (Wadhera & Nair, 1982). This increase was disproportionate; C-S rates in women "under the age of 20 years have more than tripled, while for women 20 years and older they have doubled" (Wadhera & Nair, 1982, p. 50). Reasons for the increasing C-S rate include: 1) technological innovation that facilitated therapeutic intervention (Bottoms, Rosen & Sokol, 1980), 2) changing indications for C-S (Baskett, 1978), 3) repeat Caesarean sections (Baskett, 1978), and 4) increased concern for newborns due to the "decline in overall birth rates" and "the tendency towards rising maternal age" (Wadhera & Nair, 1982, p. 47).

Vayda (1973) reported that in 1968 the C-S rate in Canada was 1.2 times that of England and Wales. In 1968, significant variation in C-S rates throughout the Canadian provinces existed (Vayda & Anderson, 1975). At this time Alberta had the sixth highest C-S rate when compared to the other provinces. In a recent study, the AHUC (1981) found substantial variation in C-S rates among thirteen areas in Alberta. Thus, it is apparent that, despite the non-discretionary nature of this procedure, rate variation among regions has been observed and significant rate increases have occurred.

2.4.3 Prostatectomy

Prostatectomy refers to the surgical removal of the prostate gland, a structure found only in males. This procedure is usually classified as discretionary. Some Canadian researchers have reported prostatectomy rates as one component of their studies, although no reports were found of specific investigations of prostatectomy rates.

Vayda and Anderson (1975) indicated that in 1968, British Columbia had the highest prostatectomy rate (252 per 100,000 persons), almost twice the lowest provincial rate. In an earlier study, Vayda (1973) reported that the prostatectomy rate in Canada was approximately twice that found in England or Wales. Vayda, Lyons, and Anderson (1977) studied surgical rates in Ontario and found that prostatectomy rates had increased 20% from 1968 to 1973. In Alberta, the Hospital Utilization Committee (1981) suggested that prostatectomy rates varied throughout the province by as much as 192%.

In a recent Alberta study, Bako, Smith, and Hanson (1982) documented evidence linking high prostate cancer incidence to high environmental cadmium concentrations. Although prostate cancer is not the only indication for prostatectomy, the Bako et al. study offers some preliminary epidemiological evidence for variable prostatectomy rates. These researchers noted two extremes of prostate cancer incidence: 1) Camrose with a significantly lower rate (10.6 per 100,000 persons), and 2) Medicine Hat with a significantly higher rate (53.2 per 100,000 persons). The Bako et al. study offers some preliminary explanation for the results of the AHUC (1981) study in which the province of Alberta was divided into thirteen study areas; the Medicine Hat area was shown to have the highest rate of prostatectomy surgery in 1978, and the sixth highest rate in 1976.

2.4.4 Cholecystectomy

Cholecystectomy, surgical removal of the gall bladder, is typically classified as a discretionary procedure "as it may be indicated for 'preventive' as well as therapeutic reasons" (Horne & Beck, 1978, p. 1007). Stockwell and Vayda (1979) have categorized this procedure as usually discretionary. In Canada, cholecystectomy rates for women are typically about three times greater than the rates for men (Dobrodzicki, 1978; Statistics Canada, 1982).

From 1968 to 1972, the cholecystectomy rate in Canada increased by approximately 23% (Vayda, Morison & Anderson, 1976). Dobrodzicki (1978) noted that in 1974 cholecystectomy was the second most frequently performed procedure in Canada and that from 1969 to 1974 the cholecystectomy rate had increased 9% and 21% for men and women respectively. This procedure also accounted "for more in-patient days than any other surgical procedure performed in Canadian hospitals" (Horne & Beck, 1978, p. 1007). With regard to the cholecystectomy rate in Alberta, the AHUC (1981) reported a decrease in the rate from 1976 to 1978.

Substantial variation in cholecystectomy rates has been reported in Canada (AHUC, 1981; Cageorge, Roos & Danzinger, 1981; Statistics Canada, 1982; Stockwell & Vayda, 1979) and in the United States (Gittelsohn & Wennberg, 1977; Lewis, 1969). Cageorge et al. (1981, p. 510) noted that variation in cholecystectomy rates had been attributed to "varying rates of clinical and radiologic investigation and use of different indications for surgical treatment." Anomalous cholecystectomy rates in Saskatchewan prompted investigation of the influence of both medical and extra-medical factors (e.g., the patient's social status, resource availability) on the care process experienced by women who had undergone a cholecystectomy in 1971 (Horne & Beck, 1978). Extra-medical factors were found to be weakly correlated with surgical rates.

Vayda (1973) reported that in 1968 the cholecystectomy rate was five times higher in Canada than in England or Wales. The AHUC (1981) documented substantial cholecystectomy rate variation among thirteen regions in Alberta. Plant, Percy and Bates (1973, p. 249) examined cholecystectomy rates in three similar cities in Canada, France, and England, for the years 1961 and 1971, and found that "the incidence of gallbladder disease is six times higher in North America than in Western Europe." However, generalization of the study results from three cities to two vast land areas cannot be considered appropriate without much more extensive study.

In summary, it is evident that: 1) cholecystectomy rates in Canada have increased over the time period from 1969 to 1974, and 2) significant rate variation among similar regions has been documented.

2.4.5 Hysterectomy

Hysterectomy refers to the surgical removal of the uterus, and as such, this operation is restricted to females who are typically fifteen years of age or older. The broad spectrum of current indications for hysterectomy prompted Stockwell and Vayda (1979) to classify it as usually discretionary. Burchell (1977) speculated that a transition from anatomic to functional indications had characterized the criteria used in decisions to perform hysterectomies. However, hysterectomy for symptom relief in the absence of an established diagnosis, or solely for the purpose of sterilization remain controversial procedures (Dyck, Murphy, & Murphy, 1976).

The Hysterectomy Committee of the College of Physicians and Surgeons of Saskatchewan was formed to examine the hysterectomy rate in Saskatchewan from 1970 to 1975. This committee was formed when it was noted that during the period from 1964 to 1971, the number of hysterectomy procedures performed in the province had increased 72.1%, while the number of women 15 years of age or older had increased only 7.6% (Dyck, Murphy, & Murphy, 1977). Vayda, Morison and Anderson (1976) studied Canadian and provincial rates for selected surgical procedures for the years 1968 to 1972, and documented a 41% increase in the Canadian hysterectomy rate. These researchers also found that the hysterectomy rate had risen in every province during this time period; Alberta's increase from 1968 to 1972 was 49%, second only to Newfoundland's increase of 85% (Vayda, Morison, & Anderson). A decrease in the Alberta hysterectomy rate over the time period from 1976 to 1978 was found by the AHUC (1981). Dobrodzicki (1978) noted that abdominal hysterectomy was the sixth most frequently occurring operation in Canada in 1974, and also found that this procedure demonstrated a 3% increase during the years 1969 to 1974. Walker and Jick (1979) reported that the U.S. had also experienced a substantial increase in hysterectomy rates during the period from 1970 to 1975.

International comparisons between Canada and England and Wales revealed a Canadian hysterectomy rate 2.2 times higher than either England or Wales (Vayda, 1973). In a smaller study that also examined rate variation, Stockwell and Vayda (1979) noted a five-fold variation in the hysterectomy rates among regions in Ontario. The results of an Alberta study which investigated surgical utilization rates in thirteen different regions in Alberta indicated that the highest hysterectomy rate was 83% higher than the lowest hysterectomy rate (Alberta Hospital Utilization Committee, 1981).

The previously mentioned studies indicate that there has been a sustained increase in the hysterectomy rate in Canada generally, as well as in Alberta until 1976. Substantial rate variation within areas of Canada and within the province of Alberta also appear to exist.

2.4.6 Tonsillectomy and Adenoidectomy

Tonsillectomy and adenoidectomy (T&A) refer to discretionary procedures that involve surgical removal of the tonsils and adenoids respectively. In Canada, removal of these structures was the most frequently performed operation in 1974 (Dobrodzicki, 1978), with 99% of all T&A's performed on persons 24 years of age or less (Statistics Canada, 1982). Vayda, Morison and Anderson (1976) concluded that between 1968 and 1972 T&A rates had declined by approximately 33% in every province. Statistics Canada

(1982) data indicated that Canada had witnessed a continuous decline in T&A rates from 1973 to 1978. Freeman, Jekel, and Freeman (1982) observed analogous decreases in T&A rates for all age and sex groups in the U.S. population from 1970 to 1977. Since no alternative therapy has been developed to replace the T&A procedure, its decline remains puzzling (Moore & Pratt, 1981). Moore and Pratt cited increased education of both physicians and the public regarding the limitations of T&A operations as a potential mitigating factor. Roos and Gilbert (1979, p. 101) argued that the rate of decline of T&A's was not sufficient, as previous research by Roos, Roos, and Henteleff (1977) demonstrated that, of the children referred for T&A, 60% had clinical histories that failed to "conform to standards recommended by medical authorities."

Imprecise indications and an incomplete understanding of the benefits associated with T&A procedures have fostered the controversy which surrounds these operations. Paradise (1972, p. 648) emphasized that "despite an immense clinical literature, conclusive studies of the indications for, and results of, tonsillectomy and adenoidectomy are lacking." Similarly, Shaikh, Vayda, and Feldman (1976) reviewed 29 studies done during the years 1922 to 1970, in which researchers had attempted to evaluate the efficacy of T&A operations, and found that definitive evidence was lacking due to inadequately designed studies.

With regard to variation in surgical rates among different regions, T&A operations have been frequently studied, as their elective nature is presumed to account for greater variation than would emergency or non-discretionary procedures. In a comparison of selected surgical rates among Canada, England, and Wales, Vayda (1973) found that age/sex standardized T&A rates in Canada were approximately twice those found in either England or Wales.

In a Canadian study that examined surgical rates throughout the Canadian provinces during 1968, Vayda and Anderson (1975) found that provincial rates for T&A varied by about 100%. Alberta had the second highest T&A rate (1007 per 100,000 persons), a rate approximately two times the lowest rate (Newfoundland, 469 per 100,000 persons). In a more recent study, Stockwell and Vayda (1979) studied surgical rates in Ontario counties and observed an eightfold variation in T&A rates throughout these counties.

In summary, T&A rates have declined in both Canada and the U.S., and it appears that a substantial proportion of T&A surgeries do not meet commonly accepted criteria for surgery (LoGerfo, Dynes & Frost, 1978; Roos & Gilbert, 1979), and surgical rate variation among geographic areas is commonly found.

2.4.7 Summary

Of the six surgical categories examined, two had declining rates (tonsillectomy and adenoidectomy, and appendectomy), while the other four (cholecystectomy, hysterectomy, prostatectomy, and Caesarean section) generally exhibited rate increases. Variable incidence in the rate of occurrence of all six categories of surgery among regions in both Alberta and Canada characterized the utilization experience of the province and the country.

2.5 Patient Origin-Destination Methodologies

Comparisons of surgical utilization rates over time and among regions have occurred due to concern for the health status of a given population, as surgical rate variation is suggestive of varying disease incidence as well as over or under utilization. The concept of rate comparison requires that the population consuming a particular set of surgical resources be known. While this concept appears intuitively obvious, the subsequent discussion will reveal that per capita utilization rates have been deceptively difficult to calculate since Canadian hospitals generally do not have predetermined areas or populations that they are expected to serve. Methodologies that involve the use of "patient origin-destination" data (data concerning the patient's usual residence and the location at which care was received) have facilitated examination of patient flow to care facilities, the delineation of service areas and service populations, as well as comparative studies of resource utilization (Raasok, 1979; Toll, 1982). As such, patient origin-destination research strategies appear to provide a method for meeting the objectives of this study, and have, therefore, been reviewed.

2.5.1 Patient Origin-Destination Flow Patterns

Information concerning patient origin-destination flow patterns has been used in various ways to assist those evaluating or planning health care service delivery. Some of the ways these flow data have been used are reviewed below.

Ciocco and Altenderfer (1945) recognized the degree to which valid rate calculation depended upon accurate determination of the population actually served by a hospital. Rather than assuming that patients travelled to the closest care facility, these researchers used birth statistics in a patient origin-destination study to quantitatively illustrate "the pattern of dependence of some counties upon the medical facilities of other counties" (Ciocco & Altenderfer, p. 973). They argued the need for the establishment of medical trade areas that would delineate the actual users of a given facility, and suggested that political boundaries could not logically convey useful information for comparative analyses. MacStravic (1978) echoed this suggestion, and cited the failure of the Hill-Burton legislation in the United States, which attempted to provide adequate distribution of medical resources to all people, as partly due to the belief that the choice of a care facility was determined by political jurisdictions.

Using data for a ten-year period, Zuckerman (1977) examined the flow patterns of patients from their communities to the place of hospitalization, and delineated the location from which each hospitals' patient came, and conversely, the hospitals used by patients in each community. By combining this information, Zuckerman summarized the interdependence which characterized the relationship among the study hospitals and the surrounding communities.

From a different perspective, many researchers have been concerned with spatial and temporal accessibility to hospital services, and have incorporated these concepts into the examination of patient flow patterns. Jehlik and McNamara (1952) were among the first researchers to specifically examine the relationship between distance from a health care resource and differential utilization. Their premise was that distance from selected health care resources was inversely related to the use of such resources, and positively related to the incidence of bed illness at home. The relationship between use and distance was confirmed; however, there was minimal evidence indicating a positive relationship between bed illness and increasing distance from a health care facility. In a later article, Marrinson (1964) commented that differential accessibility could be effectively portrayed with a "time circle" rather than a "space circle" as improved transportation routes had made urban hospitals more accessible to outlying areas. Shannon and Dever (1974) suggested that perceived travel time might better represent a measure of patient effort than objective clock time.

Patient origin-destination studies have also been used to investigate the influence of factors other than distance on patient flow patterns. Sharp and McCarthy (1971) studied patient origin-destination utilization data from three American states, and concluded that the majority of patients travelled to the nearest hospital for care. Additionally, patients appeared to be willing to travel greater distances for specialized care, and travelling distance was found to be positively related to the length of hospital stay. Bashshur, Shannon, and Metzner (1971) used patient origin-destination data to investigate the influence of socioeconomic factors and distance on accessibility of service. They found that distance was important, but that the choice of "hospital or of physician is not necessarily based primarily on accessibility" (Bashshur, Shannon & Metzner, p. 74). Of the patients studied, 43% indicated that they would go to the hospital recommended by their physician regardless of its proximity.

In summary, although distance minimization is obviously an important determinant of patient origin-destination flow patterns, hospital characteristics and patient factors are also influential.

2.5.2 Delineation of Service Areas and Service Populations

A natural outgrowth following the determination of patient utilization patterns was the delineation of hospital service areas and hospital service populations. The importance of defining a health facilities' service constituency has been predicated on the belief that effective and efficient planning were necessarily dependent upon the accurate assessment of the geographic and demographic characteristics of the population to be served (MacStravic, 1978).

Service area boundaries have frequently been determined by using previously established administrative boundaries for which census information was routinely collected. The computation of utilization rates (for the service areas) assumed the existence of reliable information concerning the number of persons in a geographic area. In early studies, hospital service areas were defined as "the smallest geographic subdivision of a planning region whose hospitals provide the overwhelming bulk of the patient days utilized by the population of the area" (Shonick, 1976, p. 61). It was often erroneously assumed that those persons living within a service area sought care only from facilities located within the service area. Thus, even in instances where a substantial number of residents crossed service area boundaries for care, the denominator for rate calculations was still incorrectly assumed to be the population of the service area.

One of the earliest studies, in which construction of service areas was based on actual utilization patterns, was done by Lembcke (1952) who, in an attempt to assess the quality of medical care, used age/sex adjusted patient origin-destination data to compare appendectomy rates among twenty-three service areas. Service area boundaries for the study hospitals were made to conform to township lines (the smallest unit for which U.S. census data was available), with the majority of service areas accounting for "75 to 95 percent of all hospitalizations of persons who resided therein" (Lembcke, p. 277). Unlike some researchers, Lembcke did not assume that people always received care in the service area in which they resided, and thus, allocated operations to the residence location of the patient regardless of where the operations were performed. Lembcke recognized that his methodology would have limited application in cases where several hospitals served a particular service area.

In a later study completed in 1962, Poland and Lembcke established equal-likelihood service areas by aggregating townships in the state of Kansas such that the boundary lines represented the point at which patients were equally predisposed to travel to particular study hospital(s), as opposed to seeking care at all other hospitals (Griffith, 1972). Subsequent analysis of these service areas indicated that disease complexity was positively related to the distance travelled for service, and also that hospitals with specialized services tended to attract patients from greater distances than those lacking such services (Shonick, 1976).

Later studies expanded the use of patient origin-destination data using a service area concept with somewhat limited success. Drossness, Reed and Lubin (1965) used population data based on census tract boundaries and computer graphic techniques to visually illustrate the spatial relationship between patients and health care facilities. In a subsequent study, Drossness and Lubin (1966, p. 94) suggested that birth certificate data classified by census tract could be used to yield "a reasonably good estimate of the ratio of total patients being attracted to each of the hospitals from all areas in the community." Meade (1974) employed a modified gravity concept of human interaction to establish service areas in the rural state of Idaho. The gravity concept was based on Newtonian physics which indicated that "the potential attractive force between two bodies increases with the product of their masses and decreases with the distance between them" (Meade, p. 360). In Meade's study, mass was equated with the concentration of health care resources (beds, physicians, and facilities). Using zip codes to identify patient origin, service areas were established such that a place supplying "60 percent or more of its patients to one hospital was considered to be part of that hospital's service area" (Meade, p. 354). Meade acknowledged that this model would have limited usefulness in urban areas where a particular hospital was unlikely to service 60 percent or more of any one service area.

A strategy similar to that used by Lembcke (1952) and Meade (1974) was employed by Paine and Wilson (1975) in an Alberta-based study which was designed to assess whether or not there was a surplus or deficiency in the number of acute care beds. These researchers used patient origin-destination information to provide a basis for dividing the province into areas such that the majority of residents (greater than 90%) located within a specific area obtained care at hospitals also located within their resident area. Paine and Wilson used census subdivisions rather than general hospital districts as the geographic basis for their patient origin-destination study (hospital district boundaries and census subdivision boundaries are not coterminous). Since more than one hospital was located within each subdivision, comparisons of hospital utilization and patient flow patterns were compromised (Teixeira, 1975). Teixeira (1975) analyzed the methodology used by Paine and Wilson and recommended that analysis of acute care hospital utilization in Alberta be conducted using the general hospital district boundaries since in most instances only one hospital was located within each district, and since these areas could be used to divide the province into relatively small mutually exclusive and exhaustive geographic areas.

The methodological limitations inherent to geographically mapping service areas prompted researchers to investigate the possibility of determining service populations without relying on the delineation of a hospital service area. In this respect, Griffith (1972, p. 65) was one of the first researchers to recognize the utility of calculating "the proportion, or density of use of each hospital by each small population." Constructing a utilization matrix which showed the number of persons coming from all geographic areas to all hospitals for a given region, Griffith calculated two indices: the relevance index and the commitment index. The relevance index (RI) was used to denote the proportion of total admissions coming from a particular area which used a specific hospital, and represented the hospital's relevance or market penetration in the area. By multiplying each area population by its respective relevance index, and summating these values for all small areas, a hospital's service population could be estimated. The commitment index (CI) reflected the proportion of total hospital admissions committed to each small area by a given hospital, and was representative of the degree to which a particular hospital serviced different small areas.

Bay and Nestman (1980) modified the relevance and commitment indices, applied them to Alberta utilization data and demonstrated three important principles. First, and perhaps most importantly, these researchers demonstrated that hospital service populations could be "defined without direct association with a geographic area" (Bay & Nestman, p. 680), and that their methodology could be applied not only to single hospitals, but could be used from a provincial perspective to investigate many hospitals. Second, it was shown that utilization measures other than admission data could be used in per capita comparisons of resource allocation and utilization. Lastly, these researchers introduced the idea that the consideration of homogeneity assumptions pertaining to physician practice and referral patterns, and hospital specialization were important when either the relevance or commitment indices were used to measure aspects of association between hospitals and districts. Although Bay and Nestman's analysis of 1971 Alberta utilization data demonstrated significant variation among the hospitals and the hospital districts with regard to resource allocation and utilization, there was some indication that the homogeneity assumptions noted by the researchers could not be assumed, and therefore, comprehensive interpretation of the results was limited.

In the following section, a brief review of some of the ways in which patient origin-destination data have been used to compare resource utilization is presented.

2.5.3 Comparative Studies of Resource Utilization

Comparative analysis of resource utilization is dependent upon the calculation of comparable rates. Bay and Nestman (1980, 1982) and Shaughnessy (1982) demonstrated the utility of using per capita utilization measures based on patient origin-destination data in order to evaluate the performance of a health care system. Specifically, these researchers advocated the use of population-based measures rather than specific utilization statistics such as admission or occupancy rates for either hospital or district/area comparisons, since the latter do not account for patient travel across study area boundaries or the influence of supply on utilization. Shaughnessy (1982) summarized two methods that have been used to calculate per capita measures: the community-based (CB) method and the provider-based (PB) method. CB per capita utilization rates are derived by delineating a geographic area, summating the health service utilization of all residents in the area regardless of where the utilization occurred, and then dividing by the total population of the area. Provided that the populations in the geographic areas that are being compared are homogeneous with respect to sociodemographic and health service provider characteristics, and the number of age-sex adjusted population, meaningful utilization rates can be derived.

The PB method uses the relevance index as outlined by Bay and Nestman (1980, 1982), and Griffith, Restuccia, and

Tedeschi (1981) to specify the population served by a provider or group of providers by "allocating (to the provider group) portions of the population from each community served" (Shaughnessy, 1982, p. 63). The summation of the portions of populations yields the denominator for per capita measurements, while the numerator may be the total resource use or cost incurred by the provider. With this method consideration should be given to the influence of hospital size (overhead costs may be higher in smaller hospitals), availability of specialized technical resources, as well as the influence of sociodemographic characteristics of the population groups obtaining service.

The purpose of the analysis generally determines the approach used. For example, Wennberg and Gittelsohn (1973) examined population-based utilization rates for Vermont residents using a CB method and found significant variation in resource utilization. These researchers estimated the amount of resources contributed by hospitals to a given service area by "allocating facilities to each service area of the state in proportion to the use of these facilities by residents" (Wennberg & Gittelsohn, p. 1103). The summation of all hospital's contributions provided an estimate of the total resource commitment to a particular service area. In a later study, these same researchers expanded their analysis to six New England states, and found that surgical resource utilization variation "was not caused by differences in the supply of resources alone" but was also due to "differences in the style of medical practice of local physicians" (Wennberg & Gittelsohn, 1982, p. 123).

In a recent Alberta study, the AHUC (1981) divided the province into thirteen regions, and used the CB method to compare the regional surgical utilization rates of twenty different surgical procedures. Two major limitations of this study hinder interpretation of the reported rates. First, the regions do not appear to be homogeneous with regard to the sociodemographic characteristics of the populations, or with regard to the availability of specialized medical resources. For example, a northern region with two small hospitals (each having less than 50 beds) and a sparsely distributed population of approximately 20,000 has been compared to the metropolitan areas of Edmonton and Calgary. Second, the populations of some of the small areas may not have been sufficiently large to yield reliable and stable statistics.

With regard to PB analyses, the research of Griffith (1978) and Griffith et al. (1981) focussed on the development of PB per capita measures. A recent monograph by Griffith (1978) detailed eighteen PB per capita measures which could be used to evaluate aspects of hospital performance pertaining to the quantity, cost, and quality of service delivered, and also delineated a methodology that could be used to cluster hospitals that served a common area. Griffith recognized that the quality measures were quite limited, and also suggested that his methodology required further refinement to account for case-mix differences among hospitals. The practical application of these PB measures in the state of Michigan illustrated the potential usefulness of such measures for hospital planning purposes (Griffith et al. 1981). It was, however, evident that the case-mix adjustment problem remained to be resolved.

Stockwell (1977) used both CB and PB measures in an investigation concerning surgical rate variation in Ontario. Although this study suffered from a number of methodological problems, perhaps the most serious limitation concerned the researchers stated assumption that PB and CB (different terminology was used in the study) utilization measures were alternative measures which could be expected to yield similar surgical utilization rates. Although it was difficult to determine exactly what had been done in the study, the researcher did not seem to realize that the PB and CB methods measured surgical utilization from different perspectives, and that there was no predictable relationship between the results of the two methods.

Shaughnessy (1982), in addition to explaining the derivation of CB and PB measures, used fictitious data to provide a brief introduction to the ways PB and CB measures could be used simultaneously to convey information regarding resource allocation and utilization. In a very recent report, two researchers have employed this strategy to partially resolve an important health care problem. Bay and

Nestman (1982) concurrently analysed PB and CB per capita measures to provide an empirical basis for hospital bed reallocation within the province of Alberta. The major contribution of this research lies in its demonstration that both hospital and district perspectives are needed to provide the conceptual foundation necessary for an understanding of utilization and allocation measures, and to provide information relevant to planning and policy decision-making.

2.5.4 Summary

From the previous discussion, it is apparent that over the last forty years there has been a gradual evolution in sophistication toward determining a hospital's service population, and the derivation of per capita utilization rates. Researchers were initially concerned with delineating actual geographic regions which would contain the majority of the hospital's service population. In this respect, many studies used distance variables to predict hospital service areas. More realistic service areas were developed once it was formally recognized that jurisdictional boundaries did not prevent patients from seeking care in adjacent regions, and further that a patient's choice of care facility was related to a number of diverse influences.

Subsequent research by Griffith (1972) demonstrated the utility of defining service populations by determining the proportion of each district served by a particular hospital.

Since Griffith's (1972) study, Bay and Nestman (1980, 1982), Griffith (1978), and Griffith et al. (1981) expanded the use of the relevance and commitment indices and incorporated patient origin-destination data to derive CB and PB measures of per capita resource allocation and utilization.

2.6 Summary of Literature Review

This review demonstrated that a theory of surgical utilization has yet to be established. This is in part due to a lack of understanding regarding the nature of surgical utilization. Researchers attempted to examine the determinants of surgical utilization, but have largely been unable to agree on the relative importance of different factors, and have often neglected to study the interaction of determinant effects on surgical utilization. Reported variations in surgical utilization rates among similar regions, as well as reports of rapidly escalating surgical rates, were shown to have led to allegations of unnecessary surgical utilization.

A review of surgical utilization rates in Canada provided a general perspective prior to the discussion of selected aspects concerning the six surgical categories chosen for study. Surgical utilization rate variation was associated with all six procedures among areas in Alberta, Canada, and the United States.

In the last section, methodologies which involved the use of patient origin-destination information were reviewed. It was shown that there had been a gradual progression from the basic realization that arbitrary boundaries did not circumscribe patient's care-seeking travel patterns, to the development of sophisticated methodologies which could be used to outline hospital service populations without relying on the initial delineation of a geographic area. It was noted that the CB and PB methods of deriving per capita measures delineated different aspects of hospital and geographic area association, and that recently, researchers had recognized the utility of using CB and PB measures in concert to provide a comprehensive perspective of a health service system's performance.

The utility of using CB or PB methods singly depends upon data availability and the nature of the problem to be investigated. The CB method is technically easier to perform; however, since the derived measures are referenced to the residents of a particular area, inter-hospital comparisons are not possible, and therefore, investigation into resource allocation, or health service system characteristics as determinants of utilization are hampered. With the PB method per capita measures are more difficult to calculate since service populations must be established, and the influence of case-mix differences among hospitals must be removed if comparative analyses are involved. The PB method does allow one to assess a particular provider's relative performance since utilization is linked directly to a hospital. Ultimately, researchers will likely find that a combination of CB and PB measures are needed to establish a realistic perspective for the interpretation of utilization or allocation measures.

In conclusion, this review has indicated a number of pertinent methodological considerations which are important to incorporate into a study of surgical utilization rate variation. Furthermore, it is apparent that a longitudinal analysis of surgical utilization rate variation in the province of Alberta has not previously been attempted. In the following chapter the methodology used in this study is outlined.

CHAPTER III

METHODOLOGY

In this chapter the formulation and implementation of the study methodology is described through discussions pertaining to three factors: 1) the development of a research strategy, 2) the data sources used, and 3) the data analysis strategies employed.

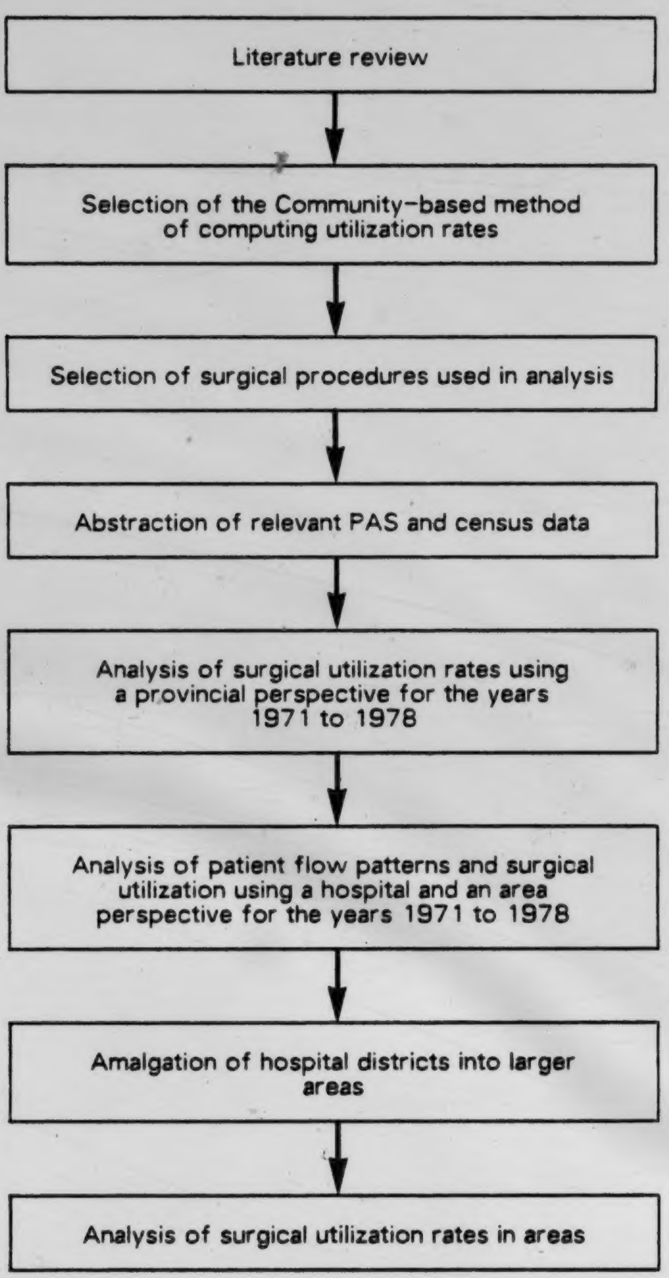
3.1 Research Strategy

The impetus for this study arose when it was noted that, although many researchers had investigated surgical utilization rate variation, the methodologies used to examine the phenomenon were often inadequate, and therefore, it was conceivable that rate variation was in part a reflection of methodological variation or data deficiency. The primary objective of this study was to determine an appropriate methodology for the comparison of surgical utilization rates among regions of the province of Alberta over the eight-year period extending from 1971 to 1978. In order to facilitate the development of a research strategy to meet this objective a number of steps were employed (see Figure 2).

Pertinent literature was reviewed in order to investigate surgical utilization trends and determinants, and to examine research methodologies suitable for calculating comparable utilization rates. Following completion of the literature review it was evident that the

Figure 2

Research Strategy


Literature review
Selection of the Community-based method of computing utilization rates
Selection of surgical procedures used in analysis
Abstraction of relevant PAS and census data
Analysis of surgical utilization rates using a provincial perspective for the years 1971 to 1978
Analysis of patient flow patterns and surgical utilization using a hospital and an area perspective for the years 1971 to 1978
Amalgation of hospital districts into larger areas
Analysis of surgical utilization rates in areas

determinants of surgical service utilization were both diverse and complex, and further, that no generally accepted theory of surgical utilization existed. The absence of a theoretical foundation to facilitate hypothesis formation and testing, and the nature of the problem being investigated meant that selection of an experimental research design was premature, and thus, inappropriate. Therefore, a descriptive exploratory approach was selected. A longitudinal retrospective design was chosen since determination of the pattern of surgical utilization rate variation was of interest, and since neither data nor adequate resources were available for the implementation of a case study or a prospective study. Previously, researchers investigating utilization and resource allocation in Alberta have analyzed one or two years of data making trend analysis impossible (see, for example, AHUC, 1981; Bay & Nestman, 1980; Paine & Wilson, 1975). Due to the controversy surrounding surgical utilization rate variation it was considered important to establish the pattern of variation over a number of years, thus a longitudinal approach (rather than a cross-sectional approach) was chosen.

The derivation of a suitable research design, which would facilitate a descriptive analysis of surgical utilization, and the selection of appropriate data and data analysis strategies were conducted while remaining cognizant of the deficiencies noted in previous analyses of surgical utilization rates. A review of pertinent methodologies indicated that there had been some progressive improvement in the methods used to compare utilization among small areas. As such, it was evident that patient origin-destination information could be used to compute comparable per capita surgical utilization rates using the methods pioneered by Griffith (1978), and Bay and Nestman (1980, 1982). Determination of the presence or absence and magnitude of surgical utilization rate variation among selected areas in Alberta constituted the problem to be investigated; therefore, an analysis which focussed on the surgical rates associated with certain geographic areas (the CB method) was thought to be more appropriate than analyses of the surgical utilization rates associated with the service populations of a particular provider or group of providers (the PB method). A CB method of calculating surgical utilization rates was chosen rather than either a PB method or the combined application of both CB and PB methods. It was recognized that the singular use of the CB method would necessarily limit any discussion of the probable reasons for rate variation since there would be no direct linkage between the calculated utilization rates and specific institutions. Also, the CB method was unlikely to yield information that could be applied to resource allocation problems. Use of the PB method would have provided an opportunity to investigate the effect of certain health service system determinants, and to compare utilization rates from a hospital perspective. However, further refinement of the PB method is required to adjust for the case-mix differences among hospitals that could potentially influence per capita measures and thereby confound an investigation of surgical utilization rate variation. This study was concerned specifically with the identification of surgical utilization rate variation among geographic areas, not the explanations for variation, and therefore, the CB method of calculating surgical utilization rates was considered most suitable.

In summary, the research strategy for this study involved the calculation of per capita surgical utilization rates for selected areas in Alberta using longitudinal, retrospective data and the application of a CB method of computation. The derivation of utilization rates for the time period from 1971 to 1978 permitted identification of certain surgical utilization trends, and an assessment of the patterns and magnitude of surgical utilization rate variation; hence, the objectives of this study were realized.

In the following two sections the data sources and data analysis strategies are discussed. The discussions reflect an emphasis on the development of a valid and reliable methodology.

3.2 Data Sources

In this section the three data sources used for the analyses and aspects pertinent to data manipulation are discussed. Since the majority of data were obtained from provincial and federal government sources, critical evaluation of the quality of the data was not possible due to its volume and the intricate data collection processes which involved large numbers of people. This type of data have been collected for many years, and quality control checks are routinely applied by those responsible for data collection and storage. It was, therefore, assumed that the likelihood of serious data deficiency was remote, and further, that due to the random occurrence of inconsequential error, the data were not biased.

3.2.1 PAS (Professional Activities Studies) Data

The primary data source for this study consisted of hospital patient discharge files for the years 1971 to 1978 which were abstracted from computer tapes containing Professional Activities Studies (PAS) data for all hospitals in Alberta. Data pertaining to acute care utilization for all hospitals were obtained to facilitate comparison between surgical utilization and acute care utilization. The data concerning surgical patients included: 1) the primary diagnosis and surgical procedure, 2) age and sex category, 3) length of hospital stay, 4) hospital and hospital district code pertaining to the location of surgery, and 5) the hospital district code referring to the patient's residence. Although other researchers (for example, AHUC, 1981, and Rutkow and Zuidema, 1981) examined a large number of surgical procedures, only data for six categories of surgery were abstracted, as an examination of all surgical utilization in the province was beyond the scope of this thesis.

Selection of Surgical Categories

The selection of surgical categories used in this study was based on several criteria. Initially, consideration was given to the similarity of surgical data over the eight-year time span of the study. PAS data are referenced to surgical procedure codes and the coding procedures have not remained constant. From 1971 to 1973 the Hospital Adaptation of the International Classification of Diseases (H-ICDA) codes were used, and from 1974 to 1978 the second edition of the H-ICDA codes were used. Therefore, it was necessary to select procedures whose coding had not changed substantially (see Appendix A.1 for a comparison between the two coding systems in relation to the procedures chosen). After this initial consideration, six categories of surgery (appendectomy, Caesarean section, prostatectomy, cholecystectomy, hysterectomy, and tonsillectomy and adenoidectomy) were selected. These categories included discretionary and non-discretionary procedures, some controversial procedures, frequently occurring procedures, and those procedures often referenced in the literature. A review of literature regarding these categories is contained in section 2.4 of this thesis.

The PAS data were readily available thus obviating the need for a sampling or data collection process; however, there were two major disadvantages to using these data. First, there is a substantial time lag in the release of PAS data which results in researchers analyzing data several years out of date. At the time that data analysis was undertaken in this study, 1978 data were the most recent available. This delay in data availability may be of concern to planners who would rather use more recent information. However, PAS data are the only comprehensive data available, and the time and costs associated with trying to obtain data through other means is prohibitive. Second, it should be recognized that the PAS data reflect actual utilization, which may or may not reflect need. While planners may desire measures of surgical need, currently a satisfactory measure of need does not exist.

3.2.2 Census Data

The second data set consisted of census data for the years 1971 and 1976 which were used to derive the district populations. The census data were arranged by nineteen age groups, by sex, and by 102 hospital districts.

Population Projections

It was critically important to select a valid and reliable method of projecting the population for the intercensal study years (1972-1975, 1977, and 1978), as following age-sex standardization, these figures formed the denominators used in the rate calculations. Two general projection models were examined: linear and exponential models. Given that the major determinants of population growth or decline are births, deaths, and migration it was difficult to postulate "a set of demographic conditions under which the population would increase or decrease by arithmetic progression" (Shyrock & Siegel, 1973, p. 377). Therefore, a linear model was not selected because its use involved the implicit assumption that the population increased or decreased by a certain number of persons per unit of time.

The selection of an exponential projection model provided a way to reflect the compounding nature of population growth, and to project a realistic pattern of growth. The available population data (1971 and 1976 census data) were compared, the constant rate of growth was calculated, and this calculated rate was then used to estimate the population for the intercensal years (see Appendix A.2). Population forecasting models which may incorporate natality, mortality, and migration information were not used as this information was not available on a district basis. The exponential model used in this study was thought to provide sufficiently accurate projections given the limited data available.

Age-Sex Adjustment

Previous research by Bay and Nestman (1980) and Rutkow and Zuidema (1981) demonstrated the importance of age and sex standardization of utilization data. With respect to this study, it was recognized that due to the age and sex specific nature of some of the surgical categories it was necessary to remove the effect of both age and sex as potential explanatory factors for surgical utilization rate variation. While it would have been desirable to standardize the population being considered with respect to cultural and socioeconomic factors, neither adequate data nor a method of adjustment were available; therefore, standardization of the district populations was limited to an age-sex adjustment. It is important to recognize that the objective of age-sex adjustment is to provide a means of comparison between areas whose population's age-sex structure may be very different; thus, the standardized surgical rate is not meaningful in and of itself. In order to differentiate the census and census projection figures from the age-sex adjusted number of persons in a district, the latter were termed the district service population following Bay and Nestman's (1980) definition. The district service populations were obtained using Bay and Nestman's (1980) indirect method which involved a weighted-sum approach (see Appendix A.3). These service population figures formed the denominators used in subsequent rate calculations.

3.2.3 Selected Government Reports

The final data source utilized in this study were the annual reports regarding hospital services issued by the provincial government. From these reports it was possible to discern the number of hospitals and their bed complements, the hospital district boundaries (see Appendix A.4), as well as certain information regarding the number and location of the surgical manpower resources in the province. The selection of hospital districts as the areas for initial study was based on three factors: 1) Teixeira's (1975) analysis had conclusively demonstrated the utility of using hospital districts, 2) census data for the hospital districts were available, and 3) hospital districts constitute the administrative unit for hospital planning. To ensure that reasonable validity of measurement was attained, the district service populations in the areas studied had to be of sufficient size to yield stable statistics, and the region (the province) under study had to be reasonably self-contained with regard to the provision and utilization of medical services in order for the study region to be regarded as a closed sytem. With regard to the first point, care was taken to aggregate the hospital districts such that the resulting service population sizes were large enough to yield stable statistics. With regard to the latter point, since the majority of Albertans are covered by provincial hospital and medical insurance, it was reasonable to assume that most residents received medical care within the province, and therefore, the closed system assumption was reasonable. This assumption was necessary since population-based per capita utilization rates were used in the analyses.

3.3 Data Analysis Strategies

Following the delineation of a research strategy and the selection of appropriate data, three types of analyses were undertaken in order to meet the objectives of this study. Explanations regarding these analyses are presented below.

3.3.1 Provincial Analysis

Using a provincial perspective, comparisons were made between surgical utilization data and acute care utilization data. Comparisons among the number and rate of separations and the days of hospital stay, average length of stay (ALOS), and other selected utilization statistics were used to provide general information. Provincial surgical utilization trends pertaining to the six categories chosen for study were also examined. The denominators used in the rate calculations were obtained from 1971 and 1976 census data and from intercensal population projections (see Appendix A.2). The numerators were calculated by aggregating the utilization data over all hospitals and districts in the province. As such, this analysis represented a macro or general approach, and was designed to provide a broad perspective of surgical utilization in the province; more detailed information was obtained from the subsequent analyses.

3.3.2 Patient Origin-Destination Travel Patterns

In order to provide background information pertinent to the examination of surgical utilization rate variation, and to meet the second objective of this study, patient travel patterns were examined. It was thought that, should subsequent analysis (as outlined in section 3.3.3) reveal significant rate variation among similar areas, explanations regarding this phenomenon might be facilitated by information concerning which hospitals served a particular area or areas, and the degree to which patients travelled outside their resident district to obtain surgical care.

Patient origin-destination matrices identical to those described by Griffith (1972) were constructed for six surgical categories, for each of the eight years studied, (i.e., 48 matrices) by cross-tabulating data concerning both the number of separations and number of patient days for the general hospital districts (origin), and the hospitals (destination) in the province. From these matrices it was possible to determine the hospitals used by district residents, and conversely, the districts served by each hospital. Using a methodology similar to that used in

Raasok's (1979) study, relevance and commitment indices were used as measures of patient flow (see Appendix A.5). The relevance indices reflected the tendency of patients to remain within, or leave their resident district to receive surgical care. The commitment indices measured the degree to which a hospital served patients located within, or external to the district in which the hospital was located. As such, the relevance indices provided information from a district perspective, while a hospital perspective was conveyed by the commitment indices. The specific analyses undertaken using each of these perspectives are discussed below. Manipulation of the large data files involved in these analyses was accomplished using a system of computer programs designed by Nie, Hull, Jenkins, Steinbrenner, and Bent (1975).

District Perspective

The three analyses performed using the district perspective were designed to provide information concerning: 1) the relationship between hospital size (measured according to the number of rated beds) and the tendency of patients to remain within their resident district to receive surgical care, 2) the number and destination of patients leaving their resident area to receive surgical care, and 3) a comparison of the ALOS of patients who remained within their resident area for surgical care and those who obtained care at hospitals not located within their resident area.

Initially, a patient flow matrix which incorporated all of the hospitals and general hospital districts was constructed. The information gained from a preliminary examination of the data provided the rationale used to collapse the matrices into smaller, more manageable groups of hospitals and hospital districts. For the first analysis, the hospital districts were assigned to one of four categories based on the size of the hospital(s) located in the district. Although this designation was somewhat arbitrary, it was based on the fact that hospital sizes naturally fall into small (8 to 49 beds), medium (50 to 299 beds), and large (300+ beds) categories. The medium-sized hospitals were sub-divided into two groups (50 to 99, and 100 to 299 beds) as the difference in the scope of services provided by a 50-bed and a 200-bed hospital may be substantial. Likewise, the hospitals were grouped according to the number of rated beds. A patient origin-destination study was then conducted, and the percentage of residents staying within each of the four district groups for each of the six surgical categories was calculated (the relevance index of the district group to the hospital(s) located in the same district group). It was, therefore, possible to examine the relationship between hospital size and the extent to which patients remained within, or left their resident district for surgical care, and to assess whether or not there had been a change in this relationship over the time period from 1971 to 1978.

In the second district analysis, assessment of both the number of patients leaving a particular area, and the location to which these patients travelled to receive care was undertaken. Due to the cumbersome nature of the large data files it was necessary to aggregate both the hospitals and the hospital districts into groups so that meaningful interpretation of both separation and patient day data was possible. Although numerous ways existed to aggregate the data, only two were performed. The resultant aggregations corresponded to those used in the analyses of surgical utilization rate variation (see Section 3.3.3). As such, the hospitals and hospital districts were aggregated twice to form: 1) a metropolitan, regional, and rural grouping, and 2) six areas designated as Calgary, Edmonton, Grande Prairie, Lethbridge, Medicine Hat, and Red Deer (see maps C and D in Figure 3, p. 107). Relevance indices which reflected the tendency of area residents to remain within, or leave their resident district to receive surgical care were calculated for the areas in both groups.

In the third district analysis, separation and patient-day information from the previous analysis were used to calculate the average length of stay (ALOS) of residents remaining within, and leaving their resident area to obtain surgical care. Subsequently, it was possible to determine whether or not ALOS varied according to the location of surgery, and to examine the ALOS trends over the eight-year time period of the study.

Hospital Perspective

In order to provide information which would correspond to the previous analyses done from the district perspective, the same hospital district aggregations were used; however, the analyses were done using a hospital perspective. The two analyses involved: 1) the determination of the percentage of surgical separations committed by certain hospitals to selected geographic areas, and 2) the calculation of the percentage of separations and days of stay generated by selected groups of hospitals.

For the first analysis, the patient origin-destination matrices for both the metropolitan/regional/rural aggregation and the six-area aggregation were used to calculate commitment indices using the method described by Griffith (1972) and Bay and Nestman (1980) (see Appendix A.5). These calculations permitted assessment of the degree to which selected groups of hospitals allocated their resources (separations) to the areas in which they were located, and to all other areas. By combining this information with that obtained from the district perspective analyses, it was possible to ascertain the demand placed on resident area and non-resident area hospitals as a consequence of patient's travel patterns.

In the second analysis, both separation and patient-day data were used to calculate the total number of separations (or days) generated by a particular group of hospitals as a percentage of the total number of separations (or days) generated by all hospitals in the province. The information from these calculations indicated which hospitals were performing the majority of the surgical procedures studied, and also provided an opportunity to compare the percentage of separations to the percentage of days generated by the different hospital groups.

In the following section the procedures used to undertake the analysis of surgical utilization rate variation are described.

3.3.3 Analysis of Surgical Utilization Rate Variation

The community-based method outlined by Bay (1982), Griffith et al. (1981), and Shaughnessy (1982) provided the basic conceptual framework for deriving the rates which were used in the analysis of surgical rate variation; however, this framework largely ignored one important practical aspect. Prior to calculating community-based utilization rates, it is necessary to divide a region (e.g., a province) into small areas such that the areas are as homogeneous as possible with regard to the presence or absence of factors likely to influence surgical utilization. It is only in this manner that accurate comparisons can be made among areas. In many studies little attention has been paid to the relationship between surgical utilization rates and dissimilar study areas. In this study, four different aggregations of the hospital districts were performed in order to demonstrate that surgical utilization rates were in part dependent upon the geographic boundaries of the areas chosen for study. In aggregating the hospital districts four ways, deliberate attempts were made to create some aggregations in which areas were as similar as possible with respect to potential determinants of surgical utilization, and other aggregations in which the areas being analyzed were dissimilar. Thus, although exactly identical rates were not expected in the similar areas due to the stochastic nature of the demand for surgical service, it was anticipated that areas with similar determinant factors would have very similar utilization rates, while those areas with dissimilar characteristics would have more variable utilization rates. It was also expected that discretionary procedures would demonstrate more variation than nondiscretionary procedures, since determinant factors were likely to have much less influence in life-threatening circumstances.

Previously, researchers have tended to assume that the most important factors influencing surgical utilization rate variation were the number of hospital beds in an area and the availability of surgical manpower. While these factors may be influential, it must be remembered that hospital bed numbers cannot necessarily be equated with the number of surgical beds, and more importantly, as was evident following the literature review, there are many societal, individual, and health service system determinants which may affect the rate of surgical utilization. The determinant factors considered prior to the aggregation of the hospital districts are discussed below.

Determinant Factors

Societal factors, such as the norms identified in the literature review, tended to be held constant across all areas of the province. For example, the majority of Albertans have hospital and medical insurance, and therefore, the effect of a financial barrier selectively limiting access to surgical service was considered inconsequential. Some hospitals do charge a registration fee to patients; however, the amount is minimal, and although the fee might pose a financial barrier to some clients, the effects of such barriers were assumed to be averaged out across all areas of the province. The influence of balance or extra-billing was not considered, since this phenomenon was not widespread during the course of the study period. Other norms concerning physician decision-making and the norms pertaining to the implicit rationing of services were also assumed to have exerted a constant influence throughout the province, and throughout the study period.

Consideration of the impact that technology might have on surgical utilization rates was very important given the variation in technical sophistication of the province's hospitals. For example, Rutkow and Zuidema (1981) noted that fetal monitoring techniques provided medical personnel with increased knowledge regarding the health of the fetus and provided the justification for therapeutic intervention in cases where the health of the fetus was compromised. Similarly, specialist medical personnel, x-ray equipment, and laboratory testing provide sophisticated technological input for clinical diagnosis and decision-making in hospitals with such resources.

In districts with large hospitals, the presence of advanced technological support may result in more surgery being performed relative to districts with smaller hospitals, due to the ability of personnel to accurately diagnose disease and implement suitable treatment. Conversely, in smaller hospitals, one might expect the diagnosis error rate to be higher due to the degree of technological support available in such hospitals. The effect of a higher diagnosis error rate (if it in fact exists) on surgical utilization is very difficult to predict, and has not been studied in Alberta. Some surgical procedures cannot be performed in smaller hospitals due to equipment or personnel limitations, and in circumstances where a districts' physicians have the option of employing non-surgical treatment techniques one might expect district residents to have lower surgical rates than those associated with residents living in districts which have larger hospitals. Alternatively, the referral practices of physicians may mean that patients living in districts with limited surgical resources are routinely referred to larger hospitals in other districts.

Determinant factors pertaining to the characteristics of individuals were very difficult to standardize across study areas. This difficulty arose due to the problems associated with identifying determinant factors and measuring their effects on surgical utilization. Demographic variables were standardized somewhat by performing age-sex adjustments to the data such that the service populations would be measured in comparable units. Standardization of residents' socioeconomic and cultural characteristics was not attempted due to the lack of information available regarding these factors. The patient flow patterns identified in the previous analyses were used to delineate areas in which people either tended to stay, or leave, to receive surgical care. It was assumed that common patient flow patterns in different areas were indicative of some common determinant factors in these areas.

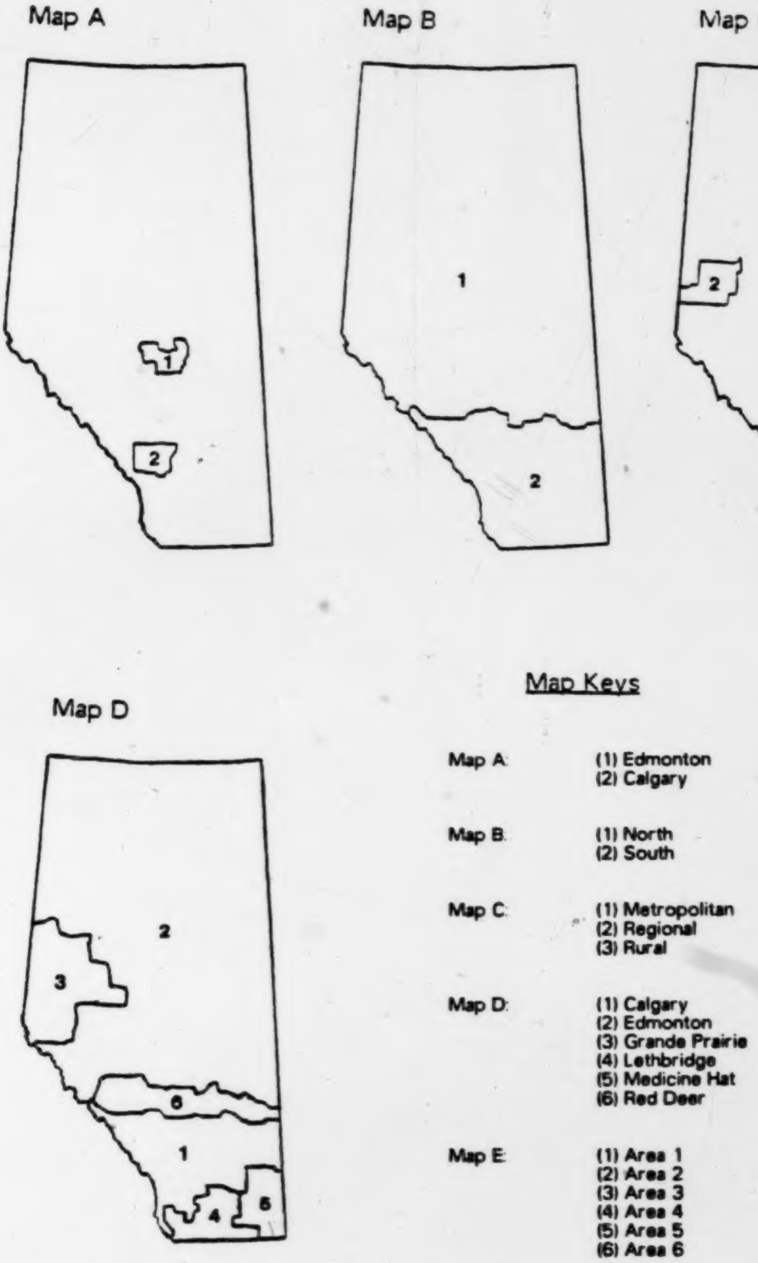
The health service system variables considered included the organization of the health care delivery system and the method of physician reimbursement. Individual hospital administrative structures and the orientation of health care programs do differ, and not all physicians are reimbursed under a fee-for-service mechanism. Additionally, patients' travel times and distances to a care facility vary considerably, and since distance to a care facility has been shown to be related to utilization, it was important to consider this variable. It was impossible to control all of these potential health service system determinants in the geographic aggregations which involved many areas. However, in some of the aggregations (see Maps A and B in Figure 3) it was reasonable to assume that, although precise identification of all health service system determinants was not possible, these determinants were likely well matched across the study areas.

It was evident that, although many determinants were identified during the literature review, those of importance for an Alberta-based study pertained to technological, individual, and certain health service system factors. Age-sex standardization of the data was done; however, adjustment of the data with respect to other factors was not attempted.

It was recognized that the rate of utilization for some surgical categories might be influenced more strongly by certain determinant factors than others (e.g., discretionary versus non-discretionary procedures). This was suggestive that different aggregations might be appropriate for different surgeries. The researcher did not explore this research strategy for two reasons. First, only six surgical categories were studied, and this number of categories was too small to be useful for deriving hypotheses regarding aggregations and types of surgery. Second, such an approach was thought impractical given the limited theoretical base concerning determinant effects on surgical utilization. Therefore, all six surgical categories were analyzed with respect to surgical utilization rate variation for each of

Figure 3

Maps Depicting Four Aggregations



the four aggregations.

The four maps in Figure 3 depict the four different ways that the province's hospital districts were aggregated. The areas in the four aggregations could be criticized for their lack of total provincial coverage (e.g., Map A), or for their lack of discrimination among small areas since such large areas were used (e.g., Map B). However, after considerable analysis of potential determinant factors, the aggregations represented in Maps A and B were the only two ways that the researcher could aggregate the hospital districts such that a homogeneity of determinant factors could be assumed. In the following section, the rationale used for the construction of the four aggregations is presented.

Map A: Edmonton and Calgary

Initially, Edmonton and Calgary, the two large metropolitan areas in the province, were compared. In order to form very similar areas for analysis it was necessary to aggregate districts 83, 84, 98, and 106 which surround the city of Edmonton, in order to form a land area similar to district 93 in which Calgary is located (see Appendix A.4 for a map and the names of the hospital districts). These two areas were considered to have very similar surgical utilization determinant factors present.

Information obtained from the patient origin-destination analyses demonstrated that in every year of the study (1971 to 1978) at least 93% of all residents in these two areas stayed within their resident district for surgery; therefore, patient flow patterns were considered to be very similar. Additionally, the public transportation system is well developed in both areas, and residents were assumed to have similar access to care. As mentioned previously, financial barriers were not thought to be of consequence due to the coverage of the majority of provincial residents by hospital and medical insurance.

Health service organization determinants and technological determinants were judged to be similar in both areas, since large hospitals, teaching hospitals, and large numbers of surgical specialists were common to both areas. Additionally, only these two areas of the province have hospitals which have more than 300 beds. Given these similarities, it was expected that the surgical utilization rates for all six surgical categories would be very similar in both the Edmonton and Calgary areas.

Map B: North and South Regions

This aggregation of the hospital districts was also designed to create two very similar areas. The dividing line between the two regions was determined by analyzing the flow patterns of residents who lived in the districts located between the Edmonton and Calgary areas identified in Map A. A boundary line was drawn such that people living north of the line tended to remain in their district or go to a northern district to receive surgical care, while those living south of the boundary line sought surgical care in southern districts. Both the north and south areas do contain a mix of rural and urban populations, and travel time to surgical services was judged to be similarly variable for residents in the two areas.

This division resulted in two regional referral centers, as well as one major referral center being located in each area. Although the northern region had approximately 20% more hospitals, and 35% more hospital beds from 1971 to 1978, the northern service population was consistently about 28% larger than the southern service population during the same time period. Thus, the health service system and technological determinants were assumed to be similar in the two areas. Due to the presence of similar determinant factors in both areas, similar utilization rates for all six surgical categories were anticipated.

Map C: Metropolitan, Regional, and Rural Areas

Construction of the metropolitan, regional, and rural areas was based on information obtained from the patient origin-destination flow studies (see section 4.3). The metropolitan area was formed by aggregating the Edmonton and Calgary areas in Map A. Residents in these areas generally remained within their resident district for surgical care. The districts in which the cities of Red Deer, Lethbridge, Medicine Hat, and Grande Prairie are located were collapsed to form the regional area which represented an aggregation of the secondary referral centres previously identified. Regional area residents also tended to remain in their resident area for surgical care although the percentage doing so was not as high as that associated with metropolitan area residents. The remainder of the hospital districts not included in either the metropolitan or regional aggregations were aggregated and designated as rural. Residents living in rural districts were most likely to leave their resident district to receive surgical care.

Determinant factors concerning patient flow patterns, the urban and rural characteristics of the populations, surgical resource availability, and patients' care-seeking patterns were assumed to be quite different among the three areas. Therefore, it was expected that surgical utilization rate variation would be found among the areas in this aggregation. Since many of the rural residents who leave their resident district are referred to the metropolitan centers for surgery (more than 50% receive care outside their resident district for some surgical procedures), it was anticipated that metropolitan and rural rates might be quite similar since the surgeons performing the procedures, although located in metropolitan areas, would actually be serving both metropolitan and rural residents.

Map D: Calgary, Edmonton, Grande Prairie, Lethbridge, Medicine Hat, and Red Deer Areas

The areas in Map D represent a breakdown of the north and south areas in Map B; the combined areas of Edmonton, Red Deer, and Grande Prairie in Map D are similar to the North area in Map B, and the combined areas of Calgary, Lethbridge, and Medicine Hat in Map D are analogous to the South area in Map B. Thus, Map D facilitated an analysis of the rates associated with regions within the north and south areas of Map B, and the areas in Map D were also similar to those used in a previous study by Paine and Wilson (1975). Although each of the six areas did have either a secondary or tertiary referral center located within its boundaries, and the vast majority of residents stayed within their resident area for surgical care, many other determinant factors were quite dissimilar among the areas. For example, travel time and distance to a health care facility, concentration of urban and rural populations, and surgical resource availability were different among the six areas. It was anticipated that for discretionary surgical procedures this aggregation would be associated with more surgical utilization rate variation than the aggregations represented in Maps A and B, due to the lack of similarity among the areas.

Surgical Utilization Rate Variation Analysis

The methodology used in this series of analyses involved calculating community-based per capita surgical utilization rates for the six surgical categories for each of the areas in the four aggregations, for the eight-year time period from 1971 to 1978. The descriptive analysis of the computed rates was undertaken from two perspectives. First, the area rates were compared, identification of areas with particularly high or low utilization rates was made, and potential explanations for observed variations were proposed. The influence of selected determinant factors was discussed; however, it was not possible to evaluate their relative influence. It was recognized that no judgement could be made regarding the necessity of surgery in these areas, or the likelihood of over or under utilization of surgical services, since surgical utilization rate standards are not available to specify appropriate levels of utilization, and since different effective methods of medical practice can be employed for particular disease states.

The second set of analyses incorporated the use of multiple regression techniques which permitted assessment of the relationship between surgical utilization rates (the dependent variable) and the different areas of patient origin (the independent variables). Thus, the relative importance of different patient origins and surgical utilization rate variation could be investigated. The multiple regression model and its application to this study are briefly described below.

Multiple Regression Model

A multiple regression model was chosen for the descriptive analysis because it facilitated examination of the simultaneous impact that a combination of independent variables (patient residence and time) had on a dependent variable (the rate of surgical utilization). From the literature review, it was apparent that a number of factors likely influenced surgical utilization. In this analysis only the influence of the aforementioned independent variables was investigated as accurate information concerning the number of surgical beds in an area, or surgical resource availability was not available.

Through the use of a step-wise regression model the independent variables which described patient residence were added to the regression equations in the order of their contribution to the coefficient of multiple determination (R-square) after the time variables had been forced to enter initially. As such, the relative contribution of each independent variable (which represented a particular area) to the explanation of variation in the dependent variable was determined after the variation in district rates that had occurred as a function of the passage of time had been removed. It was necessary to do a series of regression analyses because simultaneous assessment of the relative impact of the various patient residences represented in the four aggregations would have introduced the problem of multi-collinearity and prevented accurate interpretation of the regression results. Initially, four regression analyses were done which incorporated variables that decribed the areas in the four aggregations (Maps A, B, C, and D). In the fifth regression analysis, a composite of the influence of the areas in all four aggregations was assessed by creating variables which described the location of the two major referral centers (Edmonton and Calgary districts), the four secondary referral centers (Red Deer, Lethbridge, Medicine Hat, and Grande Prairie districts), and the areas surrounding these referral centers. As such, the influence of living within a district whose hospitals served as a referral center, and living adjacent to a district which had a referral center, could be compared with respect to the amount of variation explained in the dependent variable (surgical utilization rates).

In order to compensate for the bias that would have been introduced had different sized districts been compared without regard for dissimilar population size, and to remove the problems of non-additivity associated with ratio data, it was necessary to weight each of the cases (one for each district) by the district's proportion of the provincial population.¯ Without the application of case-weights (Nie et al., 1975), the utilization experience of populous districts (such as Edmonton and Calgary) and that of less populous districts (e.g., Olds, Hanna) would have been analyzed as though both had contributed equally to the utilization data (simple averaging). Such a computation would have rendered the regression results meaningless, since the impact of the two most populated areas in the province (which generate the greatest amount of utilization data) would become almost inconsequential when compared to one hundred smaller areas.

The dependent variable for all of the regression analyses consisted of the surgical utilization rates for each of the six surgical categories studied. The independent variables used in the five regression analyses are listed below.

Map A:

1) Calgary residence (dummy variable, 1 or 0)
2) Edmonton residence (dummy variable, 1 or 0)
3) Time (year - 1976)
4) Time-squared (non-linear transformation of the time variable)

Map B:

1) North area residence (dummy variable, 1 or 0)
2) Time (year - 1976)
3) Time-squared (non-linear transformation of the time variable)

Map C:

1) Metropolitan area residence (dummy variable, 1 or 0)
2) Regional area residence (dummy variable, 1 or 0)
3) Time (year - 1976)
4) Time-squared (non-linear transformation of the time variable)

Map D:

1) Calgary area residence (dummy variable, 1 or 0)
2) Grande Prairie area residence (dummy variable, 1 or 0)
3) Lethbridge area residence (dummy variable, 1 or 0)
4) Medicine Hat area residence (dummy variable, 1 or 0)
5) Red Deer area residence (dummy variable, 1 or 0)
6) Time (year - 1976)
7) Time-squared (non-linear transformation of the time variable)

Composite Analysis:

1) Calgary district residence

(dummy variable, 1 or 0)
2) Red Deer district residence (dummy variable, 1 or 0)
3) Medicine Hat district residence (dummy variable, 1 or 0)
4) Grande Prairie district residence (dummy variable, 1 or 0)
5) Lethbridge district residence (dummy variable, 1 or 0)
6) Edmonton area residence - not including metro Edmonton districts (dummy variable, 1 or 0)
7) Calgary area residence - not including Calgary district (dummy variable, 1 or 0)
8) Red Deer area residence - not including Red Deer district (dummy variable, 1 or 0)
9) Grande Prairie area residence - not including Grande Prairie district (dummy variable, 1 or 0)
10) Medicine Hat area residence - not including Medicine Hat district (dummy variable, 1 or 0)
11) Lethbridge area residence - not including Lethbridge district (dummy variable, 1 or 0)
12) Time (year -1976)
13) Time-squared (non-linear transformation of time variable)

The independent variables which described patient residence were all coded as dummy variables. That is, for the areas considered in each of the five regression analyses a score of either 1 or 0 was assigned to each case (district) based on whether or not the case (district) was a component of the particular area. It was necessary to omit assigning a dummy variable to one of the areas in each aggregation, since the inclusion of a dummy variable for all the areas in a particular aggregation would have resulted in linear dependency and consequently multi-collinearity. This situation occurs because the dummy variable which was assigned to the last area is completely determined by the previously specified dummies. The influence of the excluded area is reflected in the intercept value, which is termed the reference category (Nie et al., 1975). In this study the reference categories were: 1) Map A, the province exclusive of the Edmonton and Calgary areas, 2) Map B, the South area, 3) Map C, the Rural area, 4) Map D, the Edmonton area, and 5) Composite, the metro Edmonton districts (Edmonton city and surrounding areas).

The independent variables representing time were coded so that a zero would be recorded for the year 1976. As such, 1976 formed a base year to which the other years could be compared.

3.4 Summary

The methodology used to investigate the problem of surgical utilization rate variation among similar areas was presented in three sections. First, theoretical concepts evident from the literature review were used to formulate a suitable research strategy. Second, the sources of data necessary for the study were identified and discussed with regard to the data manipulations that were essential in order to assure valid and reliable measurement of surgical utilization rates. In the final section three data analysis strategies concerning: 1) assessment of provincial acute care and surgical utilization, 2) delineation of patient origin-destination travel patterns, and 3) examination of surgical utilization rate variation were discussed.

The careful development of a research strategy and selection of appropriate data and data analysis strategies were relevant to meeting the first objective of this study. The results of the analyses, which are presented in the following chapter, provide information pertinent to the second objective of the study.

CHAPTER IV

PRESENTATION AND DISCUSSION OF RESULTS

The presentation and discussion of the study results parallels the sequence of analysis strategies outlined in Chapter III. As such, the three major components of this chapter include: 1) a description of provincial acute care and surgical utilization trends, 2) the delineation of patient origin-destination flow patterns, and 3) an examination of surgical utilization rate variation among areas of the province. To enable the assessment of surgical utilization within the general context of health care utilization, a brief synopsis regarding the Alberta health care system has been presented prior to the presentation of the results.

4.1 Alberta Health Care System - Selected Aspects

In this section discussion pertaining to hospitals, hospital districts, surgical manpower resources, service populations, and relevant utilization statistics provides a system perspective and an orientation to certain factors which could potentially influence surgical utilization.

In January of 1978 the Department of Hospitals and Medical Care was formed and assumed financial and administrative responsibility for the province's hospitals; activities which from 1971 to December of 1977 had been undertaken by the Alberta Hospital Services Commission. This transfer of responsibilities did not appreciably change the operation of Alberta hospitals during 1978, and therefore, did not impact as a confounding variable in this study.

Presently, the province is divided into 102 mutually exclusive and exhaustive hospital districts. Typically, there is only one hospital in each district; however, three districts do not have a hospital, and ten districts have more than one hospital. The size and shape of these districts is extremely varied, and therefore, patients' travel times and distances to their district general hospital (or hospitals) vary considerably. Since travel time to a care facility has been shown to be related to surgical utilization, it was expected that for discretionary surgical procedures, surgical utilization rates might demonstrate an inverse relationship to the time travelled to receive care.

The number of hospitals in Alberta and their respective bed complements have changed very little from 1971 to 1978. In 1971 there were 118 general hospitals, and the number of hospital beds was estimated to be 11,095. By 1978 there were 120 hospitals and the number of beds had increased marginally to 11,390. It had been anticipated that population growth and pressure resulting from technological change would have resulted in the construction of more facilities and an increased number of hospital beds. Throughout the period of study, approximately 60% of the province's hospitals had fewer than 50 beds, and these same hospitals accounted for about 17% of all hospital beds in the province. The large metropolitan centers of Edmonton and

Calgary consistently had at least 50% of all hospital beds in the province (Alberta Hospital Services Commission, 1971-1977; Alberta Hospitals and Medical Care, 1980). From 1971 to 1978 the number of beds in the province's hospitals ranged from a minimum of 7 to a maximum of 1270.

The total number of medical practitioners in the province increased about 26% from 1973 to 1981. Surgical specialists increased in number from 430 in 1973 to 472 in 1978; figures were not available for 1971 and 1972 (Alberta Health Care Insurance Commission, 1973-1978; Alberta Hospitals and Medical Care, 1979-1981). During the same time period approximately 75% of all medical practitioners and about 88% of all surgical specialists were located in the vicinity of Edmonton and Calgary (see Appendix B.1).

From 1971 to 1978, the province's population grew from an estimated 1,629,005 to 1,934,490, an increase of 19%. The service population of the 102 districts were extremely varied and skewed. It is estimated that the range between the minimum and maximum service population values increased from 450,055 to 504,803 and that approximately 53% of the province's service population were resident within the Edmonton and Calgary districts during the time period from 1971 to 1978. Examination of the relationship between service population figures and census population figures for each district demonstrated that over the eight-year time span of the study, the number of districts having a service population within plus or minus ten percent of the census population declined from 61 to 48. Therefore, it was apparent that substantial age-sex differences existed among the district populations, and this finding reinforced the importance of performing age-sex adjustments to population figures used in utilization rate calculations.

An indepth discussion of Albertan and Canadian hospital utilization trends was not attempted since the intent in this section was only to provide background information in order to convey a general perspective. Rather, two comparative analyses of utilization were prepared. Table 1 illustrates Alberta's position relative to the other Canadian provinces with respect to four selected indicators for the years 1976 and 1981, and in Table 2 a comparison of acute care utilization and surgical utilization with respect to four age groups, for the years 1971 and 1978 has been presented.

Examination of the statistics in Table 1 indicated that from 1976 to 1981 the number of beds per 1000 persons had declined in seven of the ten provinces. Alberta ranked third highest in 1976 and sixth in 1981 with respect to this indicator, and exceeded the national index in both years. The number of separations per 1000 persons declined in most provinces; however, increases were noted in Quebec and Nova Scotia. A general decline in the number of patient days per 1000 persons was noted in seven provinces, although nationally, this indicator remained almost unchanged from 1976 to 1981. Alberta had the third highest number of

Table 1

Comparative Utilization Data for Canada and the Provinces 1976, 1981[1]

Indicator	Canada and the Provinces										
	B.C.	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	Nfld.	Canada
Beds/1000 persons											
1976	6.0	5.9	7.7	5.8	5.1	4.2	5.6	5.0	5.6	5.2	5.2
1981	5.8	5.6	6.9	5.7	4.8	4.6	6.0	5.9	5.3	5.0	5.1
Separations/1000 persons											
1976	161	186	215	162	162	106	164	131	214	146	149
1981	151	168	209	149	141	110	163	150	206	146	141
Patient Days/1000 persons											
1976	1800	1524	1971	1631	1464	1128	1667	1303	1574	1278	1435
1981	1785	1388	1852	1493	1428	1366	1740	1566	1460	1253	1475
Average Length of Stay (days)											
1976	10.3	8.0	9.1	9.9	9.0	10.5	10.7	9.9	7.4	8.2	9.4
1981	10.8	7.5	9.0	9.5	9.9	11.8	10.5	10.5	6.9	8.9	10.1

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1. Source: Statistics Canada. Hospital statistics preliminary annual report, 1977-78 and 1980-81. Catalogue number, 83-217.

separations per 1000 persons in 1976 and 1981, but was ranked sixth and eighth respectively with regard to the number of patient days per 1000 persons.

The ALOS decreased in the three prairie provinces (Alberta, Manitoba, and Saskatchewan) and in Prince Edward Island and New Brunswick, but showed marked increases in the other five provinces. Despite Alberta's relatively high number of separations (third highest), the province's ALOS was second lowest in both 1976 and 1981. The AHUC (1981, p. 18) noted this phenomenon in their examination of 1979 data and commented that this indicated:

> that either an efficient, rapid processing of patients once admitted occurred, or that Albertans may be admitted more frequently for therapeutic and diagnostic procedures, or that inappropriate admissions to hospital were being made.

To determine the relative importance of these suppositions further investigation would be required.

The statistics in Table 2 have been arranged to illustrate the utilization trends associated with four age groups (under 15, 15-44, 45-64, and 65+) for both acute care separations and surgical separations with respect to three indicators.

From 1971 to 1978 the number of acute care separations remained relatively static in the 15-44 and 45-64 age groups; a 22% decrease was noted in the under 15 age group, while the 65+ age group exhibited a 22% increase.

Table 2

Number of Separations, Days of Hospital Stay, and Average Length of Stay by Four Age Groups for Total Acute Care Separations and Surgical Separations in Canada, 1971 and 1978[1]

		Age Category				
Year	Indicator[2]	Under 15	15-44	45-64	65+	All Ages
1971	Total Acute Care Separations					
	Number of Separations	714	1547	741	567	3569
	Days of Hospital Stay	4831	11731	10252	14414	41228
	ALOS (days)	6.8	7.6	13.8	25.4	11.6
	Surgical Separations					
	Number of Separations	299	910	373	188	1771
	Days of Hospital Stay	1527	6607	4574	3608	16316
	ALOS (days)	5.1	7.3	12.3	19.2	9.2
	Percentage of Total Separations Involving Surgery	42	59	50	33	50
1978	Total Acute Care Separations					
	Number of Separations	554	1537	780	693	3563
	Days of Hospital Stay	3131	10020	9169	15119	37438
	ALOS (days)	5.7	6.5	11.8	21.8	10.5
	Surgical Separations					
	Number of Separations	218	1004	427	276	1925
	Days of Hospital Stay	1091	6530	4647	4885	16884
	ALOS (days)	5.0	6.2	10.9	17.7	8.8
	Percentage of Total Separations Involving Surgery	39	65	55	40	54

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1. Source: Statistics Canada. Surgical Procedures and Treatments, 1971 and 1978. Catalogue number 82-208.
2. The number of separations and days of hospital stay are expressed in thousands. The ALOS (days) represents the average length of stay in days.

Alternatively, the number of surgical separations increased in all but the under 15 age group, and therefore, the percentage of total separations involving surgery also tended to increase. The number of days of hospital stay associated with acute care utilization generally declined while the number of days stay associated with surgical separations generally increased. The ALOS declined for both acute care and surgical separations in all age groups during the time period from 1971 to 1978.

The number of separations was consistently highest in the 15-44 age group regardless of the nature of the separation or the year studied because of the large proportion of persons in this age category. The 65+ group had the greatest number of acute care days of hospital stay which likely reflects the extended stay associated with the multiple morbidity and chronic disease common in older people. The 15-44 age group had the greatest number of days of hospital stay associated with surgical separations. The percentage of total separations which involved surgery was also greatest in the 15-44 age group and is probably indicative of the frequent gynecological and obstetrical procedures performed on females in this age group. The rate of acute care separations per 100,000 persons and days of stay per 100,000 persons was consistently highest in the 65+ age group. As expected, the ALOS increased consistently with advancing age for both acute care and surgical separations.

In summary, it is evident that, in comparison to the other Canadian provinces, Alberta tends to have an average number of beds and a relatively high number of separations per 1000 persons, and a fairly low ALOS and low number of patient days per 1000 persons. From a national perspective it was shown that from 1971 to 1978 the number of separations attributable to acute care utilization had remained quite static, while the number of surgical separations had increased. With respect to the four age groups examined, the greatest number of acute care days of hospital stay was generated by the 65+ age group, while the 15-44 age group used the greatest number of surgical days of hospital stay. The 65+ group also had the highest rate of acute care separations and days of hospital stay. The ALOS for all age groups declined from 1971 to 1978 for both acute care and surgical separations, and was found to increase with advancing age.

In the following section acute care and surgical utilization data are analyzed from a provincial perspective.

4.2 Surgical Utilization - Provincial Perspective

Using a provincial perspective, comparison among total acute care utilization statistics, aggregate utilization associated with all six surgical categories, and the utilization associated with each of the six surgical categories indicated a number of interesting trends which are reviewed below.

4.2.1 Acute Care Utilization

The number of separations attributable to acute care hospital utilization increased by 7% from 1971 to 1978; the rate of separation per 1000 persons declined during the same period (227 per 1000 to 205 per 1000). The number of days of hospital stay associated with the increased number of separations remained relatively stable over the eight years, while the rate of days of hospital stay declined (1942 per 1000 to 1630 per 1000). Obviously, the increasing number of persons in the population offset the increased number of separations, and thus, the rate of separations and the rate of days stay per 1000 persons declined. The effect of the province's stable bed supply was reflected by the marginal change in the number of cases and days of hospital stay over the duration of the study period. The aforementioned Alberta trends parallel those observed nationally with the exception of the number of separations and days of hospital stay. The data from this study did not yield results identical to the Statistics Canada data reported in Table 2 due to the inclusion of different utilization data.

4.2.2 Surgical Utilization

An examination of surgical service utilization generated by all patients undergoing surgery in any one of the six surgical categories (i.e., the utilization reflects the sum of all six categories) demonstrated that the number and rate of both separations, and days of hospital stay declined during the period from 1971 to 1978. When this surgical service utilization was computed as a percentage of total acute care utilization with respect to the number of separations as well as days of hospital stay, both percentages were found to have steadily declined during the study period. During the peak year (1971) surgical separations (total for all six categories) accounted for 8.6% of all acute care separations; by 1978 this percentage decreased to 7.0%. The utilization trends associated with the six surgical categories studied were not representative of all surgical utilization in Alberta as an increase in the number of separations, and days of hospital stay, was associated with the aggregate sum of all surgical utilization from 1971 to 1978. Additionally, in the same time period the percentage of acute care separations involving surgical treatment increased from 56% to 62%.

Examination of the individual surgical categories indicated that during the study period four of the categories (appendectomy, hysterectomy, cholecystectomy, and tonsillectomy and adenoidectomy) had accounted for a decreasing percentage of total acute care hospital days of stay. Alternatively, expression of Caesarean section days of hospital stay as a percentage of total acute care hospital days of stay revealed a progressively increasing percentage from .57% to 1.18%, while for prostatectomy the percentage remained almost unchanged (see Appendix B.2).

From 1971 to 1978 the number and rate of separations per 1000 persons steadily declined for four of the six surgical categories: appendectomy, hysterectomy, cholecystectomy, and tonsillectomy and adenoidectomy (see Table 3). This trend is consistent with the findings of researchers in Canada and the U.S. with respect to appendectomy, and tonsillectomy and adenoidectomy; however, increasing rates have been associated with hysterectomy and cholecystectomy in the early 1970's. Rutkow and Zuidema's study (1981) of American surgical rates indicated that both the cholecystectomy and hysterectomy rates increased from 1966 to 1974, but declined from 1974 to 1978. In the time period studied (1971 to 1978) the number and rate of Caesarean section separations doubled, and the rate of prostatectomy separations remained relatively stable (see Appendix B.3).

Utilization by Age/Sex Group

The percentage distribution of the number of separations and days of hospital stay by age-sex group for the combined eight years of the study is shown in Table 4. The percentages pertaining to separations reflect the following trends: appendectomy, and tonsillectomy and adenoidectomy are predominently performed on persons less than 44 years of age; Caesarean section and hysterectomy

Table 3

Surgical Separation Rates per 1000 Persons,
Alberta, 1971-1978

Surgical Category	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	% increase or decrease[1]
Appendectomy	2.7	2.6	2.4	2.2	2.1	2.0	2.0	1.9	-30
Caesarean Section	1.0	1.0	1.1	1.2	1.4	1.7	1.9	2.1	+110
Prostatectomy	1.2	1.3	1.2	1.2	1.3	1.2	1.2	1.3	+8
Cholecystectomy	4.0	4.2	3.9	3.5	3.1	2.8	2.6	2.4	-40
Hysterectomy	3.6	3.7	3.5	3.4	3.2	2.9	2.9	2.8	-22
Tonsillectomy and Adenoidectomy	8.6	6.9	6.0	5.5	5.7	4.9	4.7	4.4	-49

1. Comparison of 1978 rates to 1971 rates respectively.

Table 4

Percentage by Column of Total Separations and Days of Hospital Stay (bracketed numbers) by Age-Sex Group[1]
(Separations for the years 1971 to 1978 have been combined)

Age-Sex Category		Surgical Categories and Acute Care Utilization[2].						
		App.	C-S.	Pro.	Cho.	Hys.	T&A.	AU.
Male	0-14	18 (17)	-	0 (0)	0 (0)	-	39 (37)	15 (11)
	15-44	29 (27)	-	1 (1)	8 (7)	-	7 (9)	12 (10)
	45-64	4 (6)	-	26 (20)	12 (13)	-	0 (0)	8 (10)
	65-74	1 (2)	-	39 (36)	4 (7)	-	0 (0)	4 (7)
	75+	0 (1)	-	34 (43)	2 (4)	-	0 (0)	4 (8)
Female	0-14	17 (16)	0 (0)	-	0 (0)	0 (0)	40 (37)	12 (9)
	15-44	28 (26)	100 (100)	-	40 (32)	63 (59)	13 (16)	29 (20)
	45-64	2 (3)	0 (0)	-	25 (24)	34 (36)	0 (0)	9 (11)
	65-74	0 (1)	0 (0)	-	6 (8)	3 (4)	0 (0)	4 (6)
	75+	0 (1)	0 (0)	-	2 (4)	1 (1)	0 (0)	4 (8)

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1. Percentages may not always sum to one hundred due to rounding error.
2. The names of the surgical categories have been abbreviated as follows: App. represents appendectomy, C-S. represents Caesarean Section, Pro. represents prostatectomy, Cho. represents cholecystectomy, Hys. represents hysterectomy, T&A. represents tonsillectomy and adenoidectomy, and AU. represents total acute care utilization.

occur most frequently in the 15-44 age group; the prostatectomy procedure occurs most often in those aged 65 years or more; and cholecystectomy shows a typical concentration in the 15 to 64 year old age bracket, with females accounting for 73% of all cholecystectomy separations. In comparison, males and females in the 0-14 and 15-44 age groups accounted for 68% of all acute care separations, while 16% of all acute care separations were attributable to persons over age 65.

Typically, the percentage of total separations and the percentage of total days stay within each surgical category were quite similar; the greatest difference was observed in the 65-74 and 75+ age groups. Examination of the days of hospital stay associated with all acute care separations demonstrated that those less than 45 years of age used 50% of all days, while the 65+ age group (which constitutes approximately 8% of Alberta's population) used 29% of all days. The 29% figure and the previously noted discrepancy between the percentage of total separations and total days stay associated with the 65+ age group are indicative of the increased length of hospital stay sometimes experienced by older persons.

Average Length of Stay

Comparison of the ALOS for the six surgical categories and acute care utilization demonstrated that, as observed nationally, the 65+ age group typically had the longest ALOS (see Table 5). The difference in ALOS between males and females was greatest for cholecystectomy, with males of all ages staying approximately 3.1 days longer than females. Males generally had the longest ALOS when either acute care or relevant surgical separations were examined.

With regard to length of hospital stay, the highest rate of days of hospital stay per 1000 persons was associated with cholecystectomy, while the lowest rates were associated with Caesarean section and tonsillectomy and adenoidectomy. For all but one of the categories (Caesarean section) the rate of days of hospital stay declined from 1971 to 1978 (see Appendix B.4).

This brief provincial analysis demonstrated selected aspects of utilization associated with the six surgical categories studied. In the following section, the results of the patient origin-destination studies are described.

4.3 Patient Origin-Destination Studies

In this section the results of the patient origin-destination analyses are presented from the perspective of the district (the patient's origin), and the hospital (the patient's destination).

Table 5

Average Length of Stay in Days by Four Age Groups and by Sex for Total Acute Care Utilization and Six Surgical Categories (Separations for the years 1971 to 1978 have been combined)

Utilization Category		Age Category[1]				
		less than 15	15-44	45-64	65+	All Ages
Acute Care Utilization	male	6.2	7.0	10.5	15.3	9.2
	female	6.1	5.8	9.8	16.7	8.0
	total	6.2	6.2	10.1	16.0	8.5
Surgical Utilization						
Appendectomy	male	6.1	6.0	9.8	15.4	6.6
	female	6.1	6.0	9.8	15.7	6.4
	total	6.1	6.0	9.8	15.5	6.5
Caesarean Section	female	12.7	10.0	18.2	12.0	10.0
Prostatectomy	male	7.4	28.7[2]	13.5	19.0	17.6
Cholecystectomy	male	11.6	10.5	13.0	21.9	14.3
	female	11.0	9.6	11.5	17.6	11.2
	total	11.1	9.8	12.0	19.4	12.0
Hysterectomy	female	8.7	9.7	11.0	15.1	10.3
Tonsillectomy and Adenoidectomy	male	2.4	3.0	4.3	3.4	2.5
	female	2.3	3.0	3.6	5.0	2.5
	total	2.3	3.0	4.0	4.2	2.5

[1] The 'less than 15' age category does not include newborns.

[2] This number was calculated using 143 separations (less than 1% of the total prostatectomy separations), and therefore, the unusually high ALOS is likely due to the presence of atypical cases.

4.3.1 District Perspective - Relevance Indices

As outlined in Chapter III the analyses conducted using the district perspective included a brief preliminary analysis and three specific analyses of the eight years of patient origin-destination data. The results of these analyses are described below.

Preliminary Analysis

Cursory examination of the 48 patient origin-destination matrices which included all of the province's hospitals and hospital districts indicated that people who travelled outside their resident district for surgery typically went to an adjacent district (whose hospital size was not necessarily larger than their resident district's hospital size), or to the closest larger center. As expected, the two major referral centers appeared to be located in Edmonton and Calgary. Secondary referral centers appeared to be located in Red Deer, Lethbridge, Medicine Hat and, to a lesser degree, Grande Prairie.

Hospital Size and Patient Travel Patterns

Examination of the four district groups (outlined in Chapter III) revealed that as the size of the hospital, as measured by the number of rated beds in the district, increased, the percentage of district residents staying within the district for surgery also increased (see Table 6). In districts with a hospital of 300 or more beds, the percentage of residents staying within the district for surgical care was 93% or more for all the years of the

Table 6

Percentage of District Residents Having Surgery in the Hospital District of their Residence

District Group[1]	Year	Surgical Categories[2]					
		App.	C-S.	Pro.	Cho.	Hys.	T&A.
1. 1-49 Beds (n=62)	1971	70	40	2	35	28	70
	1975	56	25	1	29	22	59
	1978	50	23	1	29	19	57
2. 50-99 Beds (n=28)	1971	82	67	5	63	48	79
	1975	81	52	5	59	43	77
	1978	81	50	3	53	42	80
3. 100-299 Beds (n=7)	1971	93	91	74	89	89	90
	1975	88	84	69	90	84	87
	1978	90	86	70	89	84	86
4. 300+ Beds (n=2)	1971	97	99	100	99	99	98
	1975	96	94	93	96	95	95
	1978	95	97	94	94	96	93
Across all Districts (n=99)	1971	88	84	60	81	79	88
	1975	83	75	57	77	76	82
	1978	82	74	58	74	74	82

1. Districts were assigned to a group based on the size of the hospital in the district. For example, District Group 1 refers to all the districts which have hospitals with 49 or fewer beds. The bracketed number refers to the number of districts in the group. The total number of districts sums to 99, because 3 districts do not have a hospital.
2. The names of the surgical categories have been abbreviated as follows;
App. represents appendectomy, C-S. represents Caesarean Section, Pro. represents prostatectomy, Cho. represents cholecystectomy, Hys. represents hysterectomy, and T&A. represents tonsillectomy and adenoidectomy.

study for all six surgical categories. Hospitals with 300 or more beds typically have more technological support than smaller hospitals, and are also located in large urban centers; this is likely the reason that patients living in districts which have a large hospital(s) do not often travel outside the district to receive surgical care.

Residents who lived in districts which had hospitals with 49 or fewer beds tended to travel outside their resident district for surgery more frequently than residents who lived in districts which had a hospital with a greater number of beds. This finding was expected as many of the smaller hospitals have neither adequate facilities nor suitably trained medical personnel to perform complicated surgeries. The only exception to this trend occurred with appendectomy, and tonsillectomy and adenoidectomy; at least half of all residents stayed within their resident district for these surgeries. Speculation regarding the reason for this phenomenon is tentative in the absence of indepth study. Tonsillectomy and adenoidectomy are often performed by general practitioners as well as surgeons, and these procedures are technically less difficult than some other surgeries; therefore, smaller hospitals could likely accommodate these procedures. With regard to appendectomy, the urgency of the case may prohibit patient travel to a larger center.

Over the duration of the study period, the percentage of people staying within their resident district for surgery changed minimally in districts having 100 or more beds. However, the two district groups with fewer than 100 beds were generally found to have progressively fewer residents staying within the district for surgery during the time period from 1971 to 1978. The reasons for this decrease are not known; the trend may reflect the increased mobility of district residents, as well as the difficulty of attracting surgeons and other medical personnel to the rural areas where most small hospitals are located.

In summary, it was shown that a patient's tendency to remain in their resident district for surgical care was related to the size of the hospital(s) located in the resident district. As expected, as the size of the hospital(s) increased, the percentage of residents staying within the district for surgery also increased.

Patient Travel Patterns

The previous analyses demonstrated that many patients left their resident districts to receive surgical care; the objective of this analysis was to quantify the number of persons typically leaving specific areas and to delineate their usual destinations. The inter-district travel patterns of patients resident within particular areas were not examined as the intent was only to examine travel patterns for general areas. The relevance indices calculated for the metropolitan/regional/rural aggregation (see Table 7) and the six-area aggregation (see Appendix B.5), showed that in both 1971 and 1978 the vast majority of patients received

Table 7

District Perspective: Percentage of Area Residents Receiving Surgical Care at Selected Hospitals (Relevance Indices) 1971 and 1978

		Hospital Destinations and Surgical Category[1]																				
		Metropolitan Hospitals							Regional Hospitals							Rural Hospitals						
Area of Patient Origin	Year	Ap	CS	Pr	Ch	Hy	TA	T	Ap	CS	Pr	Ch	Hy	TA	T	Ap	CS	Pr	Ch	Hy	TA	T
Metropolitan Area	1971	97	99	100	99	99	98	98	0	0	0	0	0	0	0	3	1	0	1	1	2	2
	1978	97	99	97	98	99	98	98	0	0	0	0	0	0	0	3	1	3	2	1	2	2
Regional Area	1971	1	1	13	3	1	1	2	96	98	87	94	96	94	95	3	1	0	3	3	5	3
	1978	1	4	12	4	3	1	4	93	95	88	95	94	93	93	6	1	0	1	3	6	3
Rural Area	1971	6	20	76	31	41	8	21	3	12	16	7	11	4	7	91	68	8	62	48	88	72
	1978	12	32	76	35	42	13	29	6	16	21	10	15	5	10	82	52	3	55	43	82	61

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1. The metropolitan area includes districts 83, 84, 93, 98, and 106. The regional area includes districts 14, 15, 65, and 69. The remaining districts were combined to form the rural area. The following abbreviations were used for the surgical categories: Ap, Appendectomy; CS, Caesarean Section; Pr, Prostatectomy; Ch, Cholecystectomy; Hy, Hysterectomy; TA, Tonsillectomy and Adenoidectomy; and T, the total for all six surgical categories.

surgical care at a hospital located within their resident area. This finding was anticipated given past evidence which indicated the importance of distance minimization for patients seeking medical care.

Examination of the relevance indices in Table 7 indicated that the tendency to leave one's resident area for surgical care was greatest for rural residents and least for metropolitan residents. The sufficiency of medical resources in the metropolitan and regional areas probably minimized the need for travel. With the exception of prostatectomy, regional area residents who left their resident area for surgery travelled with similar frequency to both rural and metropolitan area hospitals.

Residents in rural areas tended to remain within their resident area for appendectomy, tonsillectomy, and adenoidectomy procedures. With respect to the prostatectomy procedure, approximately 76% of all rural residents had this procedure in metropolitan area hospitals; fewer than 9% were performed in rural area hospitals. Examination of all six surgical categories as an aggregated total showed that approximately 75% of the rural residents who left their resident area obtained surgical care at metropolitan area hospitals. Additionally, over the time period from 1971 to 1978 it was apparent that for all six surgical categories a decreasing percentage of rural residents were obtaining surgical care at rural hospitals (i.e., the relevance indices of the rural area to the hospitals located in the same area were decreasing). One might have expected that rural residents who left the rural area for surgical care would have utilized the services of hospitals located in regional and metropolitan areas with similar frequency. The observed travel patterns which indicate rural residents' predominant use of metropolitan area hospitals may be a reflection of physician referral patterns, available hospital beds, and the major travel routes in the province which tend to facilitate travel to metropolitan area hospitals.

Examination of the relevance indices for the six areas (see Appendix B.5) indicated that, with the exception of prostatectomy, approximately 90% of the residents in all areas obtained surgical care at hospitals located within their resident area. This finding was expected as a previous study by Paine and Wilson (1975) had shown similar acute-care utilization patterns. Cautious interpretation of the relevance indices for the Grande Prairie and Medicine Hat areas is warranted since the total number of separations attributable to residents in each of these areas is quite small. Even a few people leaving one of these areas may account for a large percentage of the total separations, and be reflected as a fairly high relevance index of the area to hospitals not located in the same area.

In summary, it is apparent that during the time period from 1971 to 1978, with the exception of prostatectomy, the majority of patients had surgery at hospitals located within their resident area. The other major trend noted was that from 1971 to 1978 fewer rural residents tended to obtain surgical care in rural hospital facilities.

Average Length of Hospital Stay

The relevance indices in the previous analyses permitted examination of patient travel patterns. In this analysis patient-day data and separation data were used to compare the ALOS among areas in the each of the aggregations. Similar to the previous analysis, inter-district comparisons of ALOS were not performed.

The most obvious trend evident was that for patients who remained in, and travelled out of the metropolitan, regional, and rural areas the ALOS declined from 1971 to 1978 (see Appendix B.6). The ALOS for patients remaining in, and leaving their resident area differed according to the type of surgery; with the exception of prostatectomy, and tonsillectomy and adenoidectomy, the ALOS of rural area residents who left their resident area was longer, while the ALOS of metropolitan and regional area residents who left their resident area was shorter than for patients who remained within their respective resident area for surgery. Although specific reasons for this pattern of ALOS were not known, the difference may reflect the referral of the more difficult cases which require care for longer periods of time from the rural areas to metropolitan and regional area hospitals, and the likelihood of metropolitan and regional area residents to remain within their resident area especially if the surgery is expected to be difficult.

The ALOS for patients remaining within each of the six areas (six-area aggregation) typically declined from 1971 to 1978 (see Appendix B.7). The ALOS for patients who travelled out of their resident area was not calculated because the number of patients in this category was so small that a few atypical cases would have severely biased the calculations. In both 1971 and 1978 the ALOS for Grande Prairie residents was generally the lowest of the six areas; no particular area was consistently high.

In the following section, the analyses done using a hospital perspective are presented.

4.3.2 Hospital Perspective - Commitment Indices

Analysis of the commitment indices for the hospitals in all areas indicated that, with the exception of prostatectomy, hospitals committed over 80% of their surgical separations to patients resident in the area in which the hospitals were located (see Table 8 and Appendix B.8). This finding was expected since the relevance indices for the areas in the two aggregations had shown that patients tended to remain within their resident areas for surgical care.

Commitment indices for hospitals in the metropolitan and regional areas showed that from 1971 to 1978 these hospitals committed an increasing percentage of their total surgical separations to rural area residents, and that with

Table 8

Hospital Perspective: Percentage of Surgical Separations Committed by Three Hospital Groups to Three Selected Areas (Commitment Indices) 1971 and 1978

		Area of Patient Origin and Surgical Category[1]																				
		Metropolitan Area							Regional Area							Rural Area						
Hospitals	Year	Ap	CS	Pr	Ch	Hy	TA	T	Ap	CS	Pr	Ch	Hy	TA	T	Ap	CS	Pr	Ch	Hy	TA	T
Metropolitan Hospitals	1971	95	90	61	84	83	95	88	0	0	2	0	0	0	0	5	10	37	16	17	5	12
	1978	92	84	64	80	82	90	83	0	1	2	1	0	0	1	8	15	34	19	18	10	16
Regional Hospitals	1971	1	0	0	0	1	0	0	86	78	63	80	75	87	81	12	22	37	20	24	13	19
	1978	1	0	0	0	0	0	0	81	68	58	74	69	83	73	18	32	42	26	31	17	27
Rural Hospitals	1971	3	2	3	4	3	3	3	1	1	0	1	2	1	1	96	97	97	95	95	96	96
	1978	4	2	8	4	2	2	3	2	0	0	0	2	2	1	94	98	92	96	96	96	96

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[1] The metropolitan area includes districts 83, 84, 93, 98, and 106. The regional area includes districts 14, 15, 65, and 69. The remaining districts were combined to form the rural area. The following abbreviations were used for the surgical categories: Ap, Appendectomy; CS, Caesarean Section; Pr, Prostatectomy; Ch, Cholecystectomy; Hy, Hysterectomy; TA, Tonsillectomy and Adenoidectomy; and T, the total for all six surgical categories.

regard to prostatectomy, approximately one-third of their separation commitment went to rural area residents. This finding reflects the degree to which a limited number of hospitals were serving patients from many rural communities in the province.

Examination of the commitment indices in Appendix B.8 indicated that, with the exception of prostatectomy, the hospitals in all six areas committed approximately 90% of their surgical separations to patients located in the same area as the hospitals. The aforementioned patterns of resource commitment likely reflect physician referral patterns, hospital size and the technical expertise available in different hospitals, the major travel routes in the province, and factors unique to individual patients.

Location of Surgery

To determine the predominant locations where patients had undergone surgery, the percentage of total surgical separations and days of stay generated by hospitals in the areas of the two aggregations were studied. In the metropolitan/regional/rural aggregation it was evident that the majority of both surgical separations and days of hospital stay were attributable to metropolitan area hospitals, with rural area hospitals responsible for the second largest percentage of utilization (see Appendix B.9). This finding was anticipated given the distribution of hospital beds and surgical manpower in the province. During the time period from 1971 to 1978 the percentage of total separations and days stay attributable to hospitals in the three areas increased marginally for metropolitan area hospitals, decreased somewhat for rural area hospitals, and remained relatively static for regional area hospitals.

Hospitals in the Calgary and Edmonton areas of the six-area aggregation were by far the most heavily utilized (see Appendix B.10). Examination of the utilization trends over time showed that in all six areas, both the percentage of separations and days of stay for hospitals in each of the six areas had changed minimally. This finding, and the minimal changes observed among area hospitals in the other aggregation may reflect the relatively stable supply of both surgeons and hospital beds in the province. The majority of separations and days of hospital stay were generated by hospitals in the cities of Edmonton, Calgary, Red Deer, Lethbridge, and Medicine Hat. During the time period from 1971 to 1978 these cities' hospitals handled over 75% of all Caesarean sections, hysterectomies, and cholecystectomies, and 90% of all prostatectomies. The percentage of total appendectomy, tonsillectomy and adenoidectomy procedures performed in these hospitals was somewhat less, the figure being about 60%.

For all six surgical categories, and both years examined, the percentage of total separations and days of hospital stay generated by the hospitals in a particular area were remarkably similar for all areas in both aggregations. This finding attested to the similar ALOS among area hospitals within a particular aggregation.

In summary, the patient origin-destination studies done using both a district and hospital perspective indicated that patients typically remained within their resident area for care, and that hospitals committed the vast majority of their resources to patients resident within the area in which the hospital was located. The size of the hospital(s), as measured by the number of beds in the hospital(s) located within a particular hospital district, was shown to be related to the degree to which patients stayed within their resident area for surgical care; the larger the hospital, the greater was the likelihood that patients would remain within their resident district for surgical care.

In the following section the results of the analyses of surgical utilization rate variation are presented.

4.4 Analysis of Surgical Utilization Rates

Discussion of surgical utilization rate variation among the areas in each of the four aggregations is presented below in two sections: 1) the preliminary analysis of the area surgical utilization rates and, 2) the multiple regression analyses of area rates.

4.4.1 Preliminary Analysis of Area Rates

The results of the investigations concerning each of the six surgical categories are presented below. The discussion of variation among the areas was necessarily limited since determination of the degree of variation among utilization rates which would be considered beyond that due to the stochastic nature of surgical utilization was beyond the expertise of the researcher. Further study, which should involve consultation with members of the medical profession, is required to determine the point at which rate variation should be considered excessive. In the absence of accepted utilization rate standards, the area rates have been discussed with regard to their deviation from the Alberta utilization rate.

Analysis of Appendectomy Rates

Examination of the appendectomy rates among the areas of the four aggregations confirmed the trend established during the analysis of provincial utilization rates; appendectomy rates were found to have decreased significantly over the time period from 1971 to 1978 in all areas studied (see Table 9). Additionally, the area rates in all aggregations and the Alberta rates exceeded the Canadian average in every year studied.

With regard to the variation of surgical rates among areas, it was anticipated that, since appendectomy is generally regarded as a non-discretionary procedure, determinant factors would minimally influence surgical

Table 9

Appendectomy - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	2.1	2.0	2.0	1.8	1.7	1.6	1.6	1.5	1.8
Alberta	2.7	2.6	2.4	2.2	2.1	2.0	2.0	1.9	2.2
A. Calgary	2.2	2.3	2.1	2.1	1.8	1.8	1.9	1.7	2.0
Edmonton	2.5	2.4	2.2	2.0	1.9	1.9	1.8	1.8	2.0
B. South	2.6	2.6	2.4	2.2	2.1	2.0	2.0	1.8	2.2
North	2.8	2.6	2.5	2.2	2.1	2.1	2.0	2.0	2.2
C. Metropolitan	2.3	2.3	2.1	2.0	1.9	1.9	1.8	1.7	2.0
Regional	2.9	2.6	2.6	2.3	2.5	2.2	2.2	2.1	2.4
Rural	3.3	3.0	2.9	2.4	2.4	2.3	2.2	2.1	2.5
D. Calgary	2.4	2.4	2.1	2.1	1.9	1.9	1.9	1.7	2.0
Edmonton	2.7	2.5	2.4	2.2	2.0	2.0	1.9	1.9	2.2
Grande Prairie	3.6	3.0	2.9	2.6	3.1	3.5	3.5	3.3	3.2
Lethbridge	3.6	3.3	3.8	3.2	3.1	2.9	2.6	2.5	3.1
Medicine Hat	2.0	1.8	.9	1.0	1.0	1.0	1.1	1.3	1.2
Red Deer	4.1	3.8	3.5	2.4	2.9	2.1	2.2	2.2	2.9

1. The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

utilization, and therefore, minimal variation would be found. Among the areas in the first two aggregations (Maps A and B) minimal variation was found, and in some years the rates were virtually identical. This minimal variation likely reflects the matching of determinant factors in the areas of these aggregations. Although the minimal difference in some of the rates was not thought to be of importance, Calgary and the Southern area typically had lower rates than Edmonton or the Northern area. The rates for the areas in Map A were somewhat lower than the Alberta rates, while the area rates in Map B were almost identical to the Alberta rates. In the other two aggregations (Maps C and D) much more variation among the area rates was evident and some area rates were consistently higher than the Alberta rate. Comparison of the rates associated with all four aggregations enabled the researcher to form tentative conclusions regarding possible reasons for the observed variation.

Examination of the metropolitan, regional, and rural areas (Map C) demonstrated that in every year studied, the metropolitan area rates were lower than the Alberta rates; the converse was generally true for regional and rural area rates. From the previous patient origin-destination study it was shown that over the study period a decreasing percentage of rural residents remained within their resident district for the appendectomy procedure. Further analysis demonstrated that rural residents who left their resident district typically had surgery in an adjacent district, and did not travel specifically to the metropolitan areas of Edmonton and Calgary, or to the regional referral centers in Red Deer, Lethbridge, Medicine Hat, and Grande Prairie. If patients resident in a rural area had travelled predominantly to these six areas, very similar rates among metropolitan, regional, and rural areas would have been expected, since metropolitan and regional surgeons would have been making the decisions regarding removal of the appendix for many rural residents.

The higher rural area rates may be indicative of the circumstances surrounding rural residents' travel to receive care. In metropolitan and regional areas it is comparatively easy to monitor a patient suspected of having appendicitis over a prolonged period of time. However, rural residents who find it necessary to travel to receive care may not be able to make repeated trips to be monitored. Therefore, due to the constraints imposed by lengthy travel time to receive surgical care, rural residents with suspected appendicitis may have surgery more readily than urban residents who can be monitored more easily. Investigation regarding this supposition could be facilitated by a tissue study which examined the rate of removal of normal appendices from both urban and rural residents undergoing surgery in an urban hospital. If the supposition is correct, the rate of removal of normal tissue should be higher in patients referred to urban area hospitals from rural areas. During the last three years of the study (1976 to 1978) the variation among the three areas in Map C decreased which may indicate that the determinant factors related to urban/rural residence are progressively becoming less important.

Investigation of the appendectomy rates for the six areas in Map D indicated that the Lethbridge, Grande Prairie, and Red Deer areas had rates consistently higher than the Alberta rate. The Medicine Hat area rates were much lower than the Alberta rate and were the lowest of any area in the four aggregations for the eight years studied. Specific reasons for the high and low extremes were not readily apparent; however, differing physician practice patterns may be affecting utilization rates since the non-discretionary nature of the appendectomy procedure and the severity of symptoms associated with appendicitis make it unlikely that other determinant factors (except those of an epidemiological nature) would substantially influence utilization rates.

In summary, appendectomy rates have declined in all areas for the entire study period. The rates for this category appear to be consistently high in the Grande Prairie and Lethbridge areas, and consistently low in the Medicine Hat area. Two explanations for the observed variation were proposed which involved the influence of different physician practice patterns and the travel patterns of rural residents. With regard to estabishing an appropriate appendectomy rate for the entire province, it would seem that, since the rates for the matched areas in Map A and B were very similar to the Alberta rates, these rates might be regarded as providing an appropriate standard for metropolitan and regional areas. Further investigation of the circumstances surrounding appendectomy for rural residents would be needed prior to establishing a suitable rate for rural residents.

Analysis of Caesarean Section Rates

The Caesarean section (C-S) procedure is typically regarded as non-discretionary, and therefore, minimal variation among the areas of all aggregations was expected. Preliminary analysis revealed that, from 1971 to 1978, the Alberta C-S rate had generally been lower than the Canadian C-S rate, and that the C-S rate had steadily increased in the areas of all aggregations (see Table 10). This latter finding had been anticipated since a review of reports in the literature indicated that C-S rates had risen in Canada from 1968 to 1977 (Wadhera & Nair, 1982). Less variation among the rates in the four aggregations was apparent than had been associated with appendectomy; furthermore, it was evident that during the time period from 1971 to 1978 there had been progressively less variation among the areas in all four aggregations.

Examination of the C-S rates in the areas of Maps A and B indicated much more variation than had been anticipated. The Calgary area in Map A had consistently higher C-S rates than the Alberta C-S rates or those associated with the

Table 10

Caesarean Section - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	1.1	1.2	1.3	1.4	1.5	1.7	1.8	2.1	1.5
Alberta	1.0	1.0	1.1	1.2	1.4	1.7	1.9	2.1	1.4
A. Calgary	1.3	1.2	1.3	1.3	1.5	1.7	2.2	2.3	1.6
Edmonton	.8	.9	1.1	1.1	1.4	1.6	1.8	2.0	1.4
B. South	1.2	1.1	1.2	1.3	1.5	1.7	2.1	2.2	1.6
North	.8	.9	1.1	1.1	1.4	1.6	1.8	2.1	1.4
C. Metropolitan	1.0	1.0	1.2	1.2	1.4	1.7	2.0	2.1	1.5
Regional	1.3	1.2	1.5	1.5	1.7	2.1	2.3	2.5	1.8
Rural	.8	.9	1.0	1.1	1.3	1.5	1.8	2.0	1.3
D. Calgary	1.1	1.1	1.2	1.2	1.4	1.7	2.0	2.2	1.5
Edmonton	.8	.9	1.0	1.1	1.3	1.5	1.8	2.0	1.3
Grande Prairie	1.1	1.2	1.7	1.5	1.9	2.1	2.3	2.7	1.8
Lethbridge	1.6	1.4	1.6	1.7	1.8	2.2	2.3	2.2	1.9
Medicine Hat	.9	.8	1.1	1.0	1.3	1.6	2.1	1.8	1.3
Red Deer	1.1	1.1	1.2	1.4	1.5	1.9	2.2	2.7	1.7

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[1] The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

Edmonton area, and in Map B the south area typically had C-S rates higher than either the Alberta rate or the north area. Since the areas in both Map A and Map B had been closely matched with respect to potential determinant factors, epidemiological factors which might have influenced the utilization rates were investigated. It was found that in 1976 the birth rate in the Edmonton area was slightly higher than that associated with the Calgary area, and that the north area had a higher birth rate than the south area (Kosinski, 1980). Unfortunately, the variable birth rate provided confounding evidence, as a higher birth rate was associated with lower C-S rates. Given the non-discretionary nature of the procedure, and the matching of determinant factors in the two areas, it may be that other epidemiological factors, or physician practice patterns were influencing utilization rates.

Analysis of the metropolitan, regional, and rural areas in Map C showed that the regional area consistently had C-S rates higher than the Alberta rates, while the rural area rates were lower than the provincial rates. The rural C-S rates were most similar to the metropolitan C-S rates. Part of the explanation for this latter finding was evident from the patient origin-destination studies which showed that over 50% of all rural residents who left their resident area obtained care in hospitals located in the metropolitan area. Regional referral centers were utilized by rural residents secondarily. This travel pattern may be due to the presence of sophisticated fetal monitoring equipment as well as the support services offered by the neo-natal intensive care units which are found only in certain Edmonton and Calgary hospitals. The reason for the higher regional rates was unknown; however, analysis of the C-S rates associated with the areas in Map D helped to determine whether or not a particular area, which had been used to form the regional area, might have elevated the regional rates. The variation among the rates associated with the three areas in Map C suggested that determinant factors inherent to the areas formed by the aggregation of the hospital districts into metropolitan, regional, and rural areas had exerted an influence on the utilization rates.

Analysis of the areas in Map D indicated the the Grande Prairie and Lethbridge areas tended to have C-S rates higher than the Alberta rates, and that the Edmonton and Medicine Hat area rates were typically lower than the provincial rate for all of the years studied. Birth rate information supported the high rates observed in the Grande Prairie area; the high Lethbridge rates, however, were not supported by birth rate statistics. The high C-S rates associated with the Grande Prairie and Lethbridge areas probably account for the regional area in Map C having the highest area rate.

In summary, steadily increasing rates, and rate variation characterized C-S utilization in all aggregations studied. Variable birth rates offered a potential explanation for some of the observed variation; however, in some instances other epidemiological factors and physician practice patterns were thought to be influencing utilization rates. Hindsight demonstrated the utility of calculating C-S rates as the number of C-S per number of births, rather than as C-S per 1000 persons, since the former calculation would standardize areas of the province with respect to variable birth rates. The Lethbridge and Grande Prairie areas in Map D were found to have C-S rates higher than the Alberta rates, while the Edmonton and Medicine Hat areas in Map D generally had rates lower than the provincial rate. The C-S rates in the areas of Maps A and B had the least variation of the five aggregations. Establishment of a standard C-S rate for all areas in the province would require much more investigation since the C-S rate appears to still be increasing, and since reasons for the rate variation among areas are poorly understood.

Analysis of Prostatectomy Rates

Reports in the literature indicated that the prostatectomy procedure was classified as usually discretionary. Thus, more variation among area rates was anticipated than would have been expected for a non-discretionary procedure. Analysis of all areas demonstrated that between 1971 and 1978 prostatectomy rates changed minimally in the majority of areas, and that fluctuating rates were characteristic of all areas. Since a previous Alberta study had found evidence which supported a link between high environmental cadmium concentrations and significantly high prostate cancer incidence (one of the indications for prostatectomy), the areas of all four aggregations were analyzed with respect to mapped areas of high and low cadmium concentrations which were reported in a study by Bako, Smith, and Hanson (1982). It was recognized that prostatectomy is not performed solely for prostate cancer.

The areas in Maps A and B were found to have prostatectomy rates very similar to the Alberta rates (see Table 11). Slightly more variation was found between the rates for the north and south areas of Map B than between the two metropolitan areas in Map A. Analysis of the cadmium concentrations in the north and south areas indicated that the areas around Lethbridge and Medicine Hat had a particularly high cadmium content when compared to the rest of the province. This finding provided a potential explanation for the south areas' marginally higher rates (for six of the eight years), since both Lethbridge and Medicine Hat are located within the south area.

Analysis of the area rates for Map C indicated that the prostatectomy rates in the metropolitan area were lower than the Alberta average, and that the regional area rates were consistently higher than the provincial rates. The rural area rates were most similar to the metropolitan area rates. This latter finding was anticipated since the patient

Table 11

Prostatectomy - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	1.0	1.1	1.1	1.1	1.2	1.1	1.2	1.2	1.1
Alberta	1.2	1.3	1.2	1.2	1.3	1.2	1.2	1.3	1.2
A. Calgary	1.1	1.2	1.1	1.1	1.2	1.1	1.1	1.1	1.1
Edmonton	1.0	1.3	1.1	1.2	1.2	1.2	1.2	1.3	1.2
B. South	1.3	1.4	1.2	1.3	1.3	1.3	1.2	1.3	1.3
North	1.1	1.3	1.1	1.2	1.2	1.2	1.2	1.3	1.2
C. Metropolitan	1.0	1.2	1.1	1.1	1.2	1.2	1.2	1.2	1.2
Regional	1.5	1.6	1.3	1.5	1.4	1.4	1.3	1.5	1.4
Rural	1.3	1.5	1.2	1.3	1.4	1.3	1.2	1.4	1.3
D. Calgary	1.2	1.3	1.2	1.2	1.3	1.2	1.1	1.2	1.2
Edmonton	1.1	1.3	1.1	1.2	1.2	1.2	1.2	1.2	1.2
Grande Prairie	1.0	1.2	.7	.7	1.1	.8	1.0	1.0	.9
Lethbridge	1.7	1.7	1.2	1.6	1.4	1.7	1.5	1.7	1.6
Medicine Hat	1.4	1.9	1.3	1.7	1.4	1.4	1.3	1.6	1.5
Red Deer	1.5	1.5	1.5	1.7	1.4	1.6	1.5	1.7	1.5

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[1] The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

origin-destination analyses had shown that rural residents almost always left their resident district to have the prostatectomy procedure and, further, that approximately 78% travelled to a hospital in the metropolitan area. Further analysis indicated that more rural residents underwent prostatectomy in Edmonton district hospitals than in hospitals located in the Calgary district.

The rate variation in Map D also reflected a possible link between the environmental concentration of cadmium and prostatectomy; the Lethbridge, Medicine Hat, and Red Deer areas had prostatectomy rates considerably higher than the provincial rate, while the rates for the Grande Prairie area tended to be lower than the Alberta rate. One anomalous finding was evident upon examination of the Red Deer area rates. The lack of evidence linking cadmium content to prostatectomy rates in the Red Deer area may in part be due to the location from which cadmium samples were collected during the Bako et al. (1982) study. Alternatively, other determinant factors may be influencing the prostatectomy rates in the Red Deer area.

In summary, prostatectomy rates were shown to have remained almost unchanged in most areas. Much of the variation among areas was associated with the cadmium concentration, and therefore, this environmental factor was considered as a potential explanation for the observed deviation of certain area rates from the provincial rate. Less variation among area rates may be found if prostatectomy rates are based on surgery that has not been done as a result of malignancy (cancer). Establishment of a standard prostatectomy rate for all areas of the province is problematic at this time, as further investigation regarding the influence of cadmium in the environment would be needed in order to set appropriate rates for potentially dissimilar areas.

Analysis of Cholecystectomy Rates

Preliminary analysis indicated an overall decline in the area cholecystectomy rates of all four aggregations, and an Alberta rate that was very similar to the Canadian rate for the majority of years studied. Although this procedure had been labelled as discretionary in the literature, the similarity of Alberta cholecystectomy rates to the area rates, and the comparatively little variation among area rates (see Table 12) suggested that Alberta practitioners regarded cholecystectomy as a non-discretionary procedure. Alternatively, some of the variation among area rates previously noted in the literature may have been due to the lack of age and sex standardization of data; thus, the minimal variation among areas noted in this study may in part be due to the age-sex standardization of the data that was done prior to analysis.

Due to the deliberate matching of determinant factors, age-sex standardization of the data, and the absence of known epidemiological influences which might affect cholecystectomy utilization rates, minimal variation among

Table 12

Cholecystectomy - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	3.8	4.0	4.0	3.6	3.3	2.9	2.7	2.4	3.3
Alberta	4.0	4.2	3.9	3.5	3.1	2.8	2.6	2.4	3.3
A. Calgary	4.2	4.2	3.9	3.4	2.9	2.6	2.3	2.2	3.2
Edmonton	4.0	4.3	4.1	3.5	3.3	2.9	2.7	2.5	3.4
B. South	4.2	4.2	3.9	3.4	3.0	2.7	2.4	2.3	3.2
North	3.9	4.1	4.0	3.5	3.2	2.8	2.7	2.5	3.3
C. Metropolitan	4.1	4.2	4.0	3.5	3.1	2.8	2.5	2.4	3.3
Regional	4.3	4.3	3.8	3.6	3.5	2.9	2.7	2.5	3.4
Rural	3.8	4.0	3.9	3.5	3.1	2.7	2.6	2.5	3.2
D. Calgary	4.0	4.1	3.9	3.4	2.9	2.6	2.3	2.2	3.1
Edmonton	3.8	4.2	4.0	3.5	3.2	2.8	2.7	2.5	3.3
Grande Prairie	4.6	3.6	4.5	3.9	3.6	2.9	3.3	2.8	3.6
Lethbridge	4.5	4.6	4.3	3.6	3.6	3.0	2.9	2.7	3.6
Medicine Hat	4.6	4.5	3.1	3.2	3.4	2.5	2.6	3.0	3.3
Red Deer	4.0	3.7	3.7	3.9	3.1	2.9	2.6	2.5	3.3

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1. The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

the areas of Maps A and B had been anticipated; and the analysis, indeed, confirmed that very little variation existed. A similar lack of variation among the area rates in Map C suggested that determinant factors inherent to metropolitan, regional, and rural areas had little influence on cholecystectomy rates. The rural cholecystectomy rates in Map C were very similar to both regional and metropolitan areas; however, there was less variation evident between rural and metropolitan rates than between rural and regional rates. This finding probably reflects the tendency of rural area residents who leave their resident area to undergo cholecystectomy in hospitals located in metropolitan areas; metropolitan surgeons are making decisions regarding cholecystectomy for many rural residents as well as for metropolitan residents, and the commonality of decision-making is likely reflected in the similarity of rural and metropolitan cholecystectomy rates.

Examination of the areas in Map D indicated that the Grande Prairie and Lethbridge areas tended to have cholecystectomy rates higher than the provincial average, while rates for the Medicine Hat area fluctuated between high and low extremes. Reasons for the high and low rates must remain speculative in the absence of detailed information. However, since there was minimal rate variation among the areas in Map C, the rate variation observed in Map D may be due to different physician practice patterns, or to as yet unidentified epidemiological factors.

In summary, cholecystectomy rates were found to be decreasing in all areas; of the surgeries examined, the area rates for cholecystectomy deviated the least from the Alberta rates. Minimal variation among the areas of the first three Maps (A, B, and C) and the fact that there was less variation among the areas in Map D than had been observed for the procedures studied previously suggested that the determinant factors unique to particular areas did not substantially influence utilization rates, and that perhaps Alberta physicians regarded this procedure as non-discretionary. Given the lack of evidence that determinant factors (other than age and sex) influenced utilization, epidemiological factors and differing physician practice patterns were proposed as possible reasons to account for the variation that was observed.

Continued monitoring of cholecystectomy rates should determine whether or not the decrease in rates has continued, and whether or not the decline has moderated. If a levelling effect is observed, then it would seem reasonable to assume that the Alberta cholecystectomy rate would offer an appropriate standard unless medical technology provides therapies which could be used as an alternative to cholecystectomy.

Analysis of Hysterectomy Rates

A review of pertinent literature indicated that hysterectomy was typically classified as usually discretionary, and that there was a lack of consensus among medical practitioners regarding the need for this procedure. Preliminary analysis revealed that from 1971 to 1978 the hysterectomy rate had declined in all areas studied, and that the rate of decrease in the areas of Maps A and B had moderated during the last three years of the study (see Table 13). Thus, the decrease in Alberta's hysterectomy rate from 1976 to 1978 noted by the AHUC (1981) appears to have started in 1973. Surprisingly, variation among area hysterectomy rates was generally less than had been observed for appendectomy. This result was not expected as variation had previously been reported as being positively related to the discretionary nature of a procedure.

Analysis of the hysterectomy rates associated with the areas of Maps A and B indicated that, while minimal rate variation had occurred, the rates were typically higher than the Alberta rate. The variation among the area rates in Map B was greater than that found between the two metropolitan areas in Map A; however, these rates were very similar to the provincial rate. Additionally, the north area's hysterectomy rates were generally lower than those in the south area.

Examination of the hysterectomy rates for the areas in Map C indicated that the rural area rates were consistently lower, metropolitan area rates were higher, and regional rates were very similar to the provincial rates. The previous patient origin-destination study demonstrated that over 50% of all rural residents left their resident district

Table 13

Hysterectomy - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	3.1	3.1	3.1	3.0	2.9	2.6	2.7	2.6	2.9
Alberta	3.6	3.7	3.5	3.4	3.2	2.9	2.9	2.8	3.2
A. Calgary	3.6	3.6	4.0	3.5	3.6	3.1	3.2	3.1	3.4
Edmonton	4.1	4.3	3.9	3.8	3.5	3.1	3.0	2.8	3.5
B. South	3.6	3.6	3.6	3.5	3.4	3.0	3.1	3.0	3.3
North	3.6	3.8	3.4	3.3	3.1	2.8	2.7	2.6	3.1
C. Metropolitan	3.9	4.0	4.0	3.7	3.5	3.1	3.1	2.9	3.5
Regional	4.1	3.9	3.6	3.5	3.2	3.2	3.4	2.8	3.4
Rural	3.1	3.2	2.7	2.9	2.6	2.4	2.4	2.5	2.7
D. Calgary	3.4	3.4	3.7	3.4	3.4	3.0	3.1	3.0	3.3
Edmonton	3.5	3.8	3.4	3.4	3.1	2.7	2.6	2.6	3.1
Grande Prairie	3.9	2.9	2.4	2.1	2.6	2.5	2.7	2.7	2.7
Lethbridge	4.6	4.7	4.0	4.8	3.8	3.2	3.6	3.3	4.0
Medicine Hat	3.1	2.4	2.0	1.9	1.6	2.7	2.4	2.5	2.3
Red Deer	4.2	4.4	3.7	3.4	3.2	3.2	3.7	2.8	3.6

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1. The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

to have a hysterectomy, and that approximately 74% of those who left had their hysterectomy in a hospital located in either the Edmonton or Calgary districts. Thus, it was expected that the rural and metropolitan rates would be most similar; however, regional and rural hysterectomy rates were most similar for five of the eight years studied. It should be noted that the variation among the three areas in Map C was substantially less than that observed among the Map D areas. This finding suggests that since the Map C areas were dissimilar with regard to rural and urban characteristics, health service system determinants, and patient travel patterns, the effect of these determinants was much less than the determinant factors which apparently produced the greater variation among area hysterectomy rates observed in Map D.

Examination of the six areas in Map D indicated that the Lethbridge area had hysterectomy rates well above provincial rates, and that the Medicine Hat and Grande Prairie area rates were typically lower than the Alberta rate. Identification of the nature of the relationship between hysterectomy rates and determinant factors with respect to the areas in Map D was not possible due to a lack of adequate information; however, the variation among Map D areas may be due to factors related to physician practice patterns.

In summary, over the eight-year period studied, the hysterectomy rates declined in all areas. The Lethbridge area in Map D exhibited hysterectomy rates considerably higher than the Alberta rate, while the Grande Prairie and Medicine Hat areas typically had rates well below the provincial rate. Physician practice patterns were postulated as a factor which might account for the hysterectomy rate variation that was observed. Prior to establishing a hysterectomy rate standard for the province, further study would be needed to show whether or not hysterectomy rates had continued to decline, and to investigate why certain areas consistently exhibit high or low hysterectomy rates.

Analysis of Tonsillectomy and Adenoidectomy Rates

Examination of the tonsillectomy and adenoidectomy (T&A) rates indicated that from 1971 to 1978 the rate had dramatically declined (see Table 14). The researcher recognized that the calculation of T&A rates based solely on inpatient data introduced a potential source of error, since some T&A surgery is done on an outpatient basis. However, the number of T&As done as outpatient procedures was considered insignificant relative to those occurring as inpatient procedures. The T&A rate variation among the areas of all aggregations was much less than had been expected given the discretionary nature of this procedure. The greatest amount of variation was found among the areas in Map D; however, this variation was considerably less than that associated with the appendectomy rates for the areas in Map D.

Table 14

Tonsillectomy and Adenoidectomy - rate per 1000 age-sex adjusted persons

Areas Compared	Year								
	1971	1972	1973	1974	1975	1976	1977	1978	Average for 1971-1978
Canada[1]	7.7	6.3	6.2	5.7	5.0	4.4	4.3	4.0	5.4
Alberta	8.6	6.9	6.0	5.5	5.7	4.9	4.7	4.4	5.8
A. Calgary	8.4	6.8	6.2	5.7	4.9	4.3	3.7	3.9	5.4
Edmonton	8.0	6.6	5.5	4.9	5.6	4.6	4.2	3.9	5.3
B. South	8.6	6.8	6.0	5.9	5.4	4.8	4.7	4.5	5.8
North	8.6	7.0	6.0	5.3	5.9	5.0	4.7	4.4	5.8
C. Metropolitan	8.2	6.6	5.8	5.3	5.3	4.5	4.0	3.9	5.4
Regional	9.2	7.1	6.9	6.6	6.5	5.5	6.4	4.9	6.6
Rural	9.0	7.3	6.1	5.6	6.2	5.5	5.4	5.2	6.2
D. Calgary	7.9	6.4	5.7	5.4	4.9	4.5	4.0	4.0	5.3
Edmonton	8.3	6.9	5.8	5.2	5.8	4.9	4.5	4.4	5.7
Grande Prairie	15.1	10.0	8.2	6.6	7.4	5.6	5.4	5.4	7.8
Lethbridge	11.4	8.3	7.3	8.0	7.1	6.3	7.0	5.6	7.5
Medicine Hat	7.1	6.1	4.8	5.2	5.2	4.4	5.7	5.2	5.4
Red Deer	9.9	7.2	7.3	6.0	7.4	6.3	7.4	5.2	7.0

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1. The rates pertaining to Canada were calculated using data from Statistics Canada, Surgical Procedures and Treatments, 1971-1978, Catalogue number 82-208. These data were classified according to the eighth revision of the International Classification of Diseases (ICDA-8) which can not be perfectly translated into H-ICDA or H-ICDA-2 codes. Therefore, the rates for Canada are not strictly comparable to the other rates.

Analysis of the T&A rates for the areas in Maps A and B indicated that minimal variation between the area rates had occurred, and that these rates were very similar to the Alberta T&A rates. It was also evident that neither of the two areas in Map A or Map B had had consistently high or low T&A rates. Examination of the areas in Map C demonstrated that the metropolitan area T&A rates were consistently lower than the Alberta rates, while the regional area rates were typically higher. Remarkably little variation occurred among the three Map C areas from 1971 to 1976. After 1976 the variation increased in 1977, and then declined in 1978. These findings suggest that T&A rates were not greatly influenced by the determinant factors inherent to the Map C aggregation.

Analysis of the T&A rates associated with the areas in Map D indicated that the Grande Prairie, Lethbridge, and Red Deer areas tended to have rates much higher than the provincial rate. T&A rates were markedly lower than the Alberta rates in the Medicine Hat area from 1971 to 1974, and also in 1976, and in the Calgary area in 1975, 1977, and 1978. Specific reasons for the high and low extremes evident among the areas in Map D were not readily discernable; the most plausible explanatory factors appeared to be related to epidemiological phenomena or physician practice patterns.

In summary, T&A rates were shown to have substantially decreased in Alberta generally, and in the areas of all four aggregations. The amount of rate variation found among the areas in Maps C and D was less than that associated with the non-discretionary appendectomy procedure. Continued investigation of the T&A rate would seem warranted prior to establishing a standard provincial T&A rate, since the rate is still declining, and since the efficacy of these procedures has not been established.

This preliminary descriptive analysis highlighted the surgical utilization trends for six categories of surgery for each of the areas in the four aggregations. The pertinent findings from these analyses are summarized below.

1. The utilization rates of four surgical categories (appendectomy, hysterectomy, cholecystectomy, and tonsillectomy and adenoidectomy) were shown to have decreased both provincially, and in the areas of all four aggregations over the time period from 1971 to 1978. During the same time period the Caesarean section rate doubled, and the prostatectomy rate remained quite stable.
2. With regard to all six surgical categories the Lethbridge area was consistently associated with utilization rates which were markedly higher than the Alberta rate; conversely, the Medicine Hat area typically had utilization rates which were much less than the provincial average (with the exception of prostatectomy). The degree of variation among area rates considered excessive was not investigated; nevertheless,

these two areas (Lethbridge and Medicine Hat) warrant further examination to satisfy concern regarding both under and over utilization of surgical services.

3. The areas in Maps A and B consistently demonstrated the least variation among area rates for all surgical categories except Caesarean section for the eight years studied. The variation among area rates in the other two aggregations was much greater; Map D areas generally exhibited the most extreme rate variation.
4. The variation among area rates associated with appendectomy, a non-discretionary procedure, was generally greater than that associated with discretionary or usually discretionary procedures (tonsillectomy and adenoidectomy, cholecystectomy, hysterectomy, and prostatectomy). This finding was unexpected since previously researchers indicated that discretionary procedures demonstrated the greatest amount of variation.
5. The metropolitan area rates tended to be less than the provincial average; the converse was generally true for regional area rates. The tendency of rural area residents to travel to metropolitan area hospitals was reflected (with some exceptions) by the similarity between rural and metropolitan area rates.

In the following section the results of the multiple regression analyses are presented.

4.4.2 Multiple Regression Analyses

From the previous analyses it was evident that variation in surgical utilization rates among geographic areas existed. The results of the multiple regression analyses indicated the degree to which this variation could be explained by geographic factors. In the following sections the results of the multiple regression analyses done for each surgical category are discussed. Six summary tables (one for each surgical category) illustrate the influence of geographic location as an explanatory variable. A brief explanation regarding interpretation of the information in these tables is presented prior to the discussion of the results.

A step-wise multiple regression model was used as a descriptive tool in order to assess the relative contribution of each independent variable (which represented a particular district or area) to the explanation of variation in the dependent variable once the effect of time had been controlled. As such, these analyses were similar to analysis of covariance (ANCV) techniques. However, unlike ANCV, only variation due to time and areas was identified. Variation arising due to rate variation within the areas, stochastic fluctuation, and measurement error were grouped together as residuals. Inference (hypothesis testing) was not attempted as accepted theories of surgical utilization do not exist, and population data (rather than data obtained through sampling of the population) were used. Case weights

(Nie et al., 1975) were used to eliminate the bias inherent to the comparison of different sized areas, and to remove the problem of non-additivity associated with ratio data.

The independent variables listed in the tables reflect those previously described for the composite analysis in section 3.3.3 of Chapter III. The word district is used to refer to specific named districts in which referral centers are located. The word areas reflects all of the districts surrounding a particular referral center, areas that are typically rural in nature. For example, the Calgary area is made up of all the districts in the Calgary area in Map D (see Figure 3) with the exception of the Calgary district.

The relative explanatory power of each independent variable is reflected in the R-square column of the tables. It should be remembered that the R-square value is not a measure of the variation in utilization rates, but rather reflects the proportion of variation in the dependent variable (utilization rates) explained by the independent variables. As such, the R-square value reflected the variation accounted for after the influence of time and between area variation had been removed. The additive nature of the change in R-square values is interpreted as follows. If, with the addition of a particular independent variable to the regression equation, the R-square value increases by 5%, this change indicates that 5% more variation in the dependent variable is explained with the addition of this variable - not that this variable explains only 5%.

The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district rate due to a particular geographic area. In order to derive the expected utilization rate for an area or district, the relevant coefficient is added to the constant. Since the R-square values were typically very low, rate estimates should be regarded as being somewhat uncertain. Since all of the coefficients were calculated in relation to the Edmonton rates it was possible to: 1) rank the geographic areas with respect to high and low rates of utilization, 2) estimate the expected rates of utilization for a particular area or district, 3) estimate the difference in utilization rates between any two areas, and 4) determine the relationship between district utilization rates and the rates associated with the areas adjacent to each district. In the last column of the tables the percentage by which the expected utilization rate for a particular area or district deviated from the expected Edmonton district rate was depicted. As such, extreme rate variation (from the expected Edmonton district rate) could be easily noted.

In the following sections the amount of variation accounted for by a linear combination of independent variables (R-square), and the relative contribution of the independent variables which described patient residence are discussed in relation to each of the six surgical categories. The majority of the discussion focusses on the regression analysis of the composite map areas, as this finer division of the province provided more detailed information.

Appendectomy

In each of the five regression analyses the amount of variation in the dependent variable accounted for by a linear combination of the independent variables used in the regression (R-square) did not exceed 31% and was typically much lower (Map A, 18%; Map B, 10%; Map C, 18%; Map D, 26%; composite, 31%). With regard to the first four aggregations, after the initial entry of the time variables, the amount of additional variation accounted for by the variables which described patient residence location did not exceed 17% (Map A, 9%; Map B, less than 1%; Map C, 8%; and Map D, 17%). This indicated that the explanatory value of the residence variables in all four regression equations was quite limited.

The variables used in the composite regression analysis accounted for 31% of the total variation in the dependent variable. (see Table 15). After the initial entry of the time variables, the additional 22% of the variation was accounted for by the variables which described patient residence. The variable which described the Red Deer area was the first residence variable to enter the equation (accounting for 4% of the additional variation explained); it was followed by the variables representing the Lethbridge area and the Medicine Hat district which accounted for an

Table 15

Summary of Multiple Regression Analysis for Appendectomy[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time	.091	-0.080	- 4.4
Time-squared	.095	0.012	0.7
Red Deer Area	.137	1.198	65.7
Lethbridge Area	.178	1.314	72.1
Medicine Hat District	.213	-0.893	-48.9
Lethbridge District	.241	0.925	50.7
Grande Prairie District	.266	1.321	72.4
Edmonton Area	.289	0.378	20.7
Grande Prairie Area	.300	0.914	50.1
Calgary Area	.309	0.310	17.0
Red Deer District	.312	0.351	19.2
Calgary District	.313	-0.061	- 3.3
Medicine Hat Area	.313	0.314	17.2
(Constant)		1.824	

1. A summary of a step-wise multiple regression analysis which used the appendectomy rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (appendectomy rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Red Deer area, approximately 14% (13.7%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Red Deer area appendectomy utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Red Deer area (1.198) would be added to the constant (1.824) to yield an expected utilization rate of 3.0 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

additional 4% and 3% of the variation respectively. The other variables representing patient residence entered the regression equation in the order in which they accounted for progressively less variation.

Analysis of the unstandardized regression coefficients indicated that the Grande Prairie district and the areas surrounding the Lethbridge district typically had the highest appendectomy rates, while the Medicine Hat and Calgary district were associated with the lowest rates. With the exception of the Grande Prairie area, residents living in the areas surrounding a referral center had appendectomy rates somewhat higher than residents living in districts which had a referral center. The reasons why particular areas (or districts) have utilization rates much higher or lower than the Edmonton utilization rates (e.g., Lethbridge district +72%, Medicine Hat district -49%), or why the areas surrounding a referral district have higher utilization rates than the referral districts are not known. Since the utilization trends are similar in all areas, it is unlikely that the variation is due to small area size or to random fluctuations.

In summary, although the actual rate variation is substantial for some areas, it was evident that when the influence of time was controlled, no particular patient residence variable accounted for a substantial proportion of the variation in the dependent variable. The final regression analysis indicated that only 22% of the total variation in appendectomy rates could be explained by a linear combination of the twelve variables representing patient residence. It appears, therefore, that the variation present among district appendectomy rates cannot be adequately explained in terms of different patient residence.

Caesarean Section

The amount of variation additionally accounted for by the variables representing patient residence in the first four regression equations was negligible (Map A, 2%; Map B, 2%; Map C, 4%; and Map D, 7%). The twelve patient residence variables in the composite analysis accounted for slightly more of the additional variation (12%), bringing the R-square value to 51%. The first three resident variables to enter the equation (after the time variables), were the Edmonton area, Red Deer district, and the Grande Prairie district, which collectively explained an additional 6% of the variation in C-S rates (see Table 16). The remaining seven variables representing patient residence accounted for the additional 6% of the explained variation. (The variable representing the area surrounding the Grande Prairie district did not contribute sufficiently to the reduction in variation to be included in the regression equation, which indicated that the rate for this area was the same as the Edmonton district rate, or the constant).

Examination of the unstandardized regression coefficients showed that the lowest Caesarean section (C-S)

Table 16

Summary of Multiple Regression Analysis for Caesarean Section[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time	.372	0.231	15.1
Time-squared	.391	0.019	1.3
Edmonton Area	.414	-0.095	- 6.2
Red Deer District	.433	0.728	47.6
Grande Prairie District	.449	0.831	54.4
Calgary District	.468	0.256	16.8
Lethbridge Area	.490	0.656	42.9
Lethbridge District	.507	0.419	27.4
Calgary Area	.511	-0.171	-11.2
Medicine Hat Area	.512	0.436	28.6
Medicine Hat District	.512	-0.054	- 3.6
Red Deer Area	.512	0.039	2.6
(Constant)		1.528	

1. A summary of a step-wise multiple regression analysis which used the Caesarean section rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (Caesarean section rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Edmonton area, approximately 41% (41.4%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Calgary area Caesarean section utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Calgary area (-0.171) would be added to the constant (1.528) to yield an expected utilization rate of 1.36 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

rates were associated with the area adjacent to the Calgary district; the highest and second highest rates were found in the Grande Prairie and Red Deer districts respectively. There was no clear relationship between high and low C-S rates for residents living in districts with referral centers, and residents living in areas adjacent to a referral center. Grande Prairie, Edmonton, Calgary, and Red Deer district residents had higher C-S rates than residents living in areas adjacent to each of these districts, while the reverse pattern was evident for Lethbridge and Medicine Hat district residents.

In conclusion, once the influence of time had been removed, a minor amount of variation in the dependent variable (C-S utilization rates) was accounted for by particular patient residence variables, and collectively their explanatory value was very limited.

Prostatectomy

In all five regression analyses the variables representing time accounted for less than 1% of the additional variation in the dependent variable (district prostatectomy rates), and the calculated R-square values were very low (Map A, 4%; Map B, 3%; Map C, 5%; Map D, 11%; and the composite, 16%). In the composite analysis the patient residence variable representing the Calgary area entered the regression equation ahead of a time variable because the time-squared variable did not meet the statistical criteria necessary for its inclusion at the second step. As can be noted from Table 17, its inclusion did not appreciably change the R-square value. The variables representing the Calgary area, Lethbridge district, and the Red Deer area accounted for an additional 4%, 3%, and 3% of the variation in prostatectomy rates respectively (see Table 17). These three areas had the highest prostatectomy rates; the Grande Prairie area and district, and the Calgary district were associated with the lowest rates. With the exception of the Lethbridge and Medicine Hat districts, residents living in the areas adjacent to referral centers had higher prostatectomy rates than residents living in the districts which had referral centers.

While the aforementioned pattern of rate variation reflects previous discussion concerning the possible link between prostatectomy rates and environmental cadmium concentration, if this factor had substantially influenced prostatectomy rates, its importance should have been reflected in much higher R-square values. As such, the minimal variation accounted for by the patient residence variables indicated that geographic location was minimally important in the explanation of prostatectomy utilization rate variation among districts.

Cholecystectomy

In each of the five regression analyses the variables representing time accounted for approximately 47% of the variation in cholecystectomy rates (the dependent variable). The amount of variation explained by the addition of the

Table 17

Summary of Multiple Regression Analysis for Prostatectomy[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time	.001	-0.006	- 0.5
Calgary Area	.042	0.366	31.0
Time-squared	.042	-	-
Lethbridge District	.078	0.434	36.8
Red Deer Area	.110	0.420	35.6
Medicine Hat District	.125	0.321	27.2
Lethbridge Area	.137	0.292	24.7
Red Deer District	.151	0.298	25.2
Grande Prairie District	.158	-0.305	-25.9
Calgary District	.160	-0.043	- 3.7
Grande Prairie Area	.162	-0.182	-15.4
Medicine Hat Area	.163	0.209	17.7
Edmonton Area	.163	0.020	1.7
(Constant)		1.180	

1. A summary of a step-wise multiple regression analysis which used the prostatectomy rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (prostatectomy rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Lethbridge district, approximately 8% (7.8%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Lethbridge district prostatectomy utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Lethbridge district (0.434) would be added to the constant (1.180) to yield an expected utilization rate of 1.61 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

patient residence variables was minimal (Map A, B, and C, less than 1%; Map D, 2%; and the composite, 3%). In the composite analysis the variable representing Lethbridge area residence entered the regression equation first, following the time variables, and accounted for less than 1% of the additional explained variation (see Table 18). The remaining eleven patient residence variables collectively explained an additional 2% of the variation.

The highest cholecystectomy rates were associated with the Lethbridge area, the lowest rates with the area adjacent to the district of Calgary. Typically, residents in the districts of Grande Prairie, Edmonton, and Calgary, had higher cholecystectomy rates than residents living in the area adjacent to each of these districts. Residents in the districts of Red Deer, Lethbridge, and Medicine Hat had lower cholecystectomy rates than the rates associated with the surrounding areas.

In conclusion, once the influence of time was controlled, only a minor amount of variation in the dependent variable was explained by the addition of patient residence variables to the regression equation.

Hysterectomy

In the series of regression analyses concerning hysterectomy rate variation, the variables representing time accounted for only 14% of the explained variation in the dependent variable. The variables representing patient residence accounted for more variation than was observed

Table 18

Summary of Multiple Regression Analysis for Cholecystectomy[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time	.467	-0.298	- 9.8
Time-squared	.469	-0.009	- 0.3
Lethbridge Area	.477	0.420	13.9
Calgary Area	.482	-0.336	-11.1
Calgary District	.486	-0.197	- 6.5
Edmonton Area	.493	-0.195	- 6.4
Grande Prairie District	.495	0.380	12.5
Lethbridge District	.496	0.115	3.8
Red Deer District	.497	-0.157	- 5.2
Red Deer Area	.497	-0.010	- 3.3
Medicine Hat Area	.497	0.269	8.9
Medicine Hat District	.497	-0.064	- 2.1
Grande Prairie Area	.498	0.064	2.1
(Constant)		3.033	

1. A summary of a step-wise multiple regression analysis which used the cholecystectomy rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (cholecystectomy rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Red Deer area, approximately 50% (49.7%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Red Deer area cholecystectomy utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Red Deer area (-0.010) would be added to the constant (3.033) to yield an expected utilization rate of 3.02 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

with the other five surgical categories (Map A, 11%; Map B, less than 1%; Map C, 17%; Map D, 9%; and the composite, 31%).

Following removal of the influence of time, the first three variables to enter the regression equation for the composite analysis were the patient residence variables which described the Edmonton area, Medicine Hat district, and the Calgary area. These three variables accounted for an additional 14%, 5%, and 6% of the explained variation in hysterectomy utilization rates respectively (see Table 19). Residents living in the areas adjacent to the Medicine Hat district, and in the Lethbridge district had the highest hysterectomy rates, while those living in the areas adjacent to Edmonton and in the district of Medicine Hat had the lowest rates. With the exception of the Grande Prairie and Medicine Hat districts; the hysterectomy rate in districts with a referral center was higher than that associated with areas surrounding each of these districts.

Of the surgical categories examined in this study, this was the only one in which the patient residence variables explained a moderate amount of the variation in the dependent variable. As such, for hysterectomy, the location in which a patient resides appears to influence the likelihood of having a hysterectomy. In the absence of known epidemiological factors which might account for variation among rates, it is possible that other determinant factors related to physician practice patterns are responsible for

Table 19

Summary of Multiple Regression Analysis for Hysterectomy[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time	.135	-0.159	- 4.7
Time-squared	.136	-0.005	-0.1
Edmonton Area	.279	-0.971	-29.0
Medicine Hat District	.330	-1.411	-42.1
Calgary Area	.387	-0.873	-26.0
Lethbridge District	.412	0.692	20.6
Grande Prairie District	.426	-0.956	-28.5
Red Deer District	.437	0.586	17.5
Grande Prairie Area	.442	-0.668	-19.9
Red Deer Area	.447	-0.361	-10.8
Medicine Hat Area	.449	0.966	28.8
Calgary District	.451	-0.094	- 2.8
Lethbridge Area	.451	0.024	0.7
(Constant)		3.352	

1. A summary of a step-wise multiple regression analysis which used the hysterectomy rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (hysterectomy rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Medicine Hat district, approximately 33% (33.0%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Edmonton area hysterectomy utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Edmonton area (-0.971) would be added to the constant (3.352) to yield an expected utilization rate of 2.38 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

the rate variation. Further investigation would be required to establish causality.

Tonsillectomy and Adenoidectomy

In each of the five regression analyses, the amount of variation in the dependent variable (T&A utilization rates) accounted for by the variables which described patient residence was quite low (Map A, 4%; Map B, less than 1%; Map C, 4%; Map D, 8%; and the composite, 10%). In the composite analysis the first three variables to enter the regression equation (after the time variables) were the Lethbridge, Grande Prairie, and Red Deer areas which collectively explained an additional 5% of the variation in T&A rates (see Table 20). Analysis of the unstandardized regression coefficients indicated that the three areas mentioned previously had the highest T&A rates, while the area adjacent to the Calgary and Edmonton districts had the lowest T&A rates. With the exception of the Calgary district, residents living in the areas adjacent to referral centers typically had T&A rates somewhat higher than residents living in a district which had a referral center.

In summary, once the influence of time had been controlled, the amount of variation in the dependent variable accounted for by the variables representing patient residence was very small. As such, it appears that T&A rate variation cannot be satisfactorily explained in terms of different patient residence.

Table 20

Summary of Multiple Regression Analysis for Tonsillectomy and Adenoidectomy[1]

Independent Variables	R Square[2]	Unstandardized Regression Coefficients[3]	Coefficient Expressed As a Percentage of the Edmonton District Rate (Constant)[4]
Time-squared	.230	0.082	1.9
Time	.249	-0.267	- 6.1
Lethbridge Area	.267	2.632	60.5
Grande Prairie Area	.286	3.614	83.0
Red Deer Area	.303	2.148	49.4
Lethbridge District	.321	2.027	46.6
Edmonton Area	.338	0.863	19.8
Grande Prairie District	.344	1.742	40.0
Red Deer District	.348	1.087	25.0
Calgary Area	.351	-0.465	-10.7
Calgary District	.352	0.124	2.8
Medicine Hat Area	.352	0.580	13.3
(Constant)		4.352	

1. A summary of a step-wise multiple regression analysis which used the T&A rate per 1000 persons in each of the general hospital districts as the dependent variable. The independent variables refer to different patient residence locations and to the time variables. The analysis was performed using the WEIGHT and REGRESSION procedures outlined in SPSS: Statistical Package for the Social Sciences (Nie et al, 1975).
2. The number in the R-square column represents the amount of variation in the dependent variable (T&A rates) accounted for after the entry of a particular independent variable. For example, following the entry of the independent variable which described the Calgary area, approximately 35% (35.1%) of the variation in the dependent variable had been explained.
3. The unstandardized regression coefficients represent the expected rate difference in comparison with the Edmonton district due to a particular geographic area. In order to determine the expected Calgary area T&A utilization rate for the year 1976 (when the time variables are equal to zero) the unstandardized regression coefficient for the Calgary area (-0.465) would be added to the constant (4.352) to yield an expected utilization rate of 3.89 separations per 1000 persons.
4. The deviation of the expected area or district rates from the expected Edmonton district rate (the rate which is indicated by the constant) is shown in the fourth column.

Summary of Multiple Regression Analyses

This series of multiple regression analyses indicated that once the effect of time had been controlled, the variables which described the geographic location of patient residence accounted for a very minor amount of variation in the dependent variable (with the exception of hysterectomy). With regard to hysterectomy, since the variables in the composite analysis collectively explained an additional 31% of the variation in district hysterectomy rates, it seems that the likelihood of having a hysterectomy can in part be predicted by knowing a patient's residence location.

Analysis of the unstandardized regression coefficients for the regression equations indicated that the Lethbridge district and the surrounding area had consistently higher rates of surgical utilization for all six surgical categories, while the Calgary district and the area adjacent to it generally had lower rates than other areas or districts in the province. The relationship between high and low utilization rates and patient residence in a district with a referral center and in the areas adjacent to the referral centers was unique to each surgical category studied. The deviations of the expected surgical utilization rates derived by regression analysis are schematically summarized in Table 21, using the Edmonton district rate (the constant for the regression analysis) as the basis for the comparisons. From the table it may be noted that:

1. the Lethbridge district and area as well as the Grande

Table 21

Summary of Surgical Utilization Rate Deviation for Each Geographic Area from the Edmonton District Rate[1]

Areas[2]	Surgical Category[1]					
	App.	C-S.	Pro.	Cho.	Hys.	T&A.
Edmonton District	*	*	*	*	*	*
Edmonton Area	++	*	*	*	---	++
Calgary District	*	++	*	*	*	*
Calgary Area	++	-	+++	-	---	-
Lethbridge District	+++++	+++	++++	*	++	+++++
Lethbridge Area	+++++++	++++	++	+	*	++++++
Medicine Hat District	-----	*	+++	*	----	*
Medicine Hat Area	++	+++	++	*	+++	+
Grande Prairie District	+++++++	+++++	---	+	---	++++
Grande Prairie Area	+++++	*	--	*	--	++++++++
Red Deer District	++	+++++	+++	*	++	+++
Red Deer Area	+++++++	*	++++	*	-	+++++
Associated R-square change after addition of time and time-square variables	31%	51%	16%	50%	45%	35%

1. The following symbols are used to represent different degrees of variation: 1) each + denotes a utilization rate approximately 10% over the Edmonton district rate, 2) each - denotes a rate approximately 10% under the Edmonton district rate, and 3) a * denotes a deviation that is less than plus or minus 10% of the Edmonton district rate.
2. The following abbreviations were used to represent the six surgical categories: App., appendectomy; C-S., Caesarean section; Pro., prostatectomy; Cho., cholecystectomy; Hys., hysterectomy; and T&A., tonsillectomy and adenoidectomy.
3. Each of the areas listed does not include the referral district(s) it is surrounding.

Prairie and Red Deer districts and areas, often had expected utilization rates which deviated substantially from the expected Edmonton rate.

2. with the exception of the C-S category, the Calgary and Edmonton district rates were very similar.
3. the areas surrounding each referral district tend to have higher surgical utilization rates than those associated with the referral district.
4. variation among area and district rates was minimal for the cholecystectomy category.

Although the deviations isolated by the regression analyses are significant, interpretation of the deviations should be done with caution since the overall explanatory power (R-square) of the variables describing patient residence was relatively poor. The low R-square values likely reflect, in part, deviation values associated with relatively small areas which contributed minimally to the overall variation in utilization rates.

4.5 Summary

The results from the analyses pertaining to provincial acute care and surgical utilization, patient travel patterns and hospital resource commitment patterns, and surgical utilization rate variation were presented and discussed. A summary of the major findings from these analyses is presented in section 5.2 of the last chapter.

CHAPTER V

SUMMARY AND RECOMMENDATIONS

In this final chapter a brief synopsis of the study is presented, pertinent findings and conclusions are discussed, and four recommendations are outlined.

5.1 Summary of the Study

The release of the AHUC (1981) report which indicated substantial variation in surgical utilization rates among areas in Alberta provided the impetus for this study. Variation in the surgical utilization rates among ostensibly similar areas has typically resulted in allegations concerning the possibility of over or under utilization of surgical services. An alternative hypothesis suggested that appropriate factors might not always have been taken into account by researchers measuring and defining surgical utilization, and therefore, the possibility that rate variations were in fact an artifact of research design was investigated. Determination of the presence or absence and magnitude of surgical rate variation within the Province of Alberta constituted the problem to be investigated.

Subsequent to a review of pertinent literature, a research strategy was developed which involved the calculation of per capita surgical utilization rates for selected areas in Alberta using longitudinal retrospective PAS data and the application of a community-based method of computation. Typical patterns of travel by patients seeking surgical care were identified, as were the patterns of resource commitment by various hospital groups in the province. The derivation of rates for the time period from 1971 to 1978 permitted identification of certain surgical utilization trends, and an assessment of the patterns and magnitude of surgical utilization rate variation. Pertinent findings from the analyses are presented in the following section.

5.2 Major Findings

The major findings evident following the analyses are listed below.

1. The review of selected literature sources indicated that a comprehensive theory of surgical utilization had not been formulated, and that the determinants of surgical utilization were poorly understood. Reports of escalating surgical utilization rates and rate variation among areas in Canada, Britain, and the U.S., and among ostensibly similar areas within each of these countries were linked to allegations of unnecessary surgical utilization. A brief review concerning the measurement of surgical rates indicated that patient origin-destination information could be used to calculate community-based per capita utilization rates.
2. Analysis of the patient origin-destination information indicated that:

a. Patients resident in rural areas frequently travelled to hospitals located in metropolitan areas, rather than to regional area hospitals. This travel pattern was reflected (with some exceptions) in the similarity between rural area and metropolitan area surgical utilization rates.

b. The tendency of patients to remain within their resident district for surgical care was shown to be related to the size of the hospital(s) located in their resident district; as the size of the hospital(s) increased, the percentage of residents staying within the district for surgery also increased.

c. With the exception of the prostatectomy procedure, the majority of patients had surgery in hospitals located within their resident area (the study areas formed by aggregating the hospital districts). Similarly, hospitals in a particular area typically committed the vast majority of their resources (separations and patient days) to patients resident in the area in which the hospitals were located.

3. From 1971 to 1978 the utilization rates of four of the six surgical categories (appendectomy, hysterectomy, cholecystectomy, and tonsillectomy and adenoidectomy) decreased provincially, and in the areas of all four aggregations. During the same time period the Caesarean section rate doubled, and the prostatectomy rate

remained almost unchanged.

4. With regard to all six surgical categories the Lethbridge and Grande Prairie areas in Map D were typically associated with utilization rates which were markedly higher than the Alberta (or Edmonton and Calgary district) utilization rates. Conversely, the Medicine Hat area typically had utilization rates which were well below the provincial average (with the exception of prostatectomy).
5. The areas in Maps A and B consistently demonstrated the least variation among area rates for all surgical categories (except Caesarean section) for the eight years studied. The variation among area rates in the other two aggregations was much greater; Map D areas typically exhibited the most extreme variation from the Alberta utilization rates.
6. The variation among area rates associated with appendectomy (a non-discretionary procedure) was generally greater than that associated with discretionary or usually discretionary procedures (tonsillectomy and adenoidectomy, cholecystectomy, hysterectomy, and prostatectomy).
7. Analysis of the series of multiple regression equations indicated that, once the influence of time had been controlled, the variables which described the geographic location of patient residence accounted for a very minor amount of rate variation (with the exception of

hysterectomy, where collectively the variables describing patient residence accounted for 31% of the variation in the district rates). Of the twelve areas examined, the areas and districts associated with Lethbridge, Grande Prairie, and Red Deer were generally shown to have utilization rates which deviated substantially from the Edmonton district rate. Of the six surgical categories studied, cholecystectomy was found to have the least rate variation.

5.3 Conclusions

The principle conclusions which were evident following analysis of the data are discussed below.

1. The absence of a theoretical foundation upon which to premise hypothesis formulation meant that inference (or hypothesis testing) was premature. As such, a descriptive approach using longitudinal data was adopted. The necessity for age and sex standardization of data was recognized, and the importance of standardizing areas for comparison with respect to all probable determinants of surgical utilization was acknowledged. The utility of using both community-based and provider-based methods of rate calculation in concert to provide a comprehensive perspective of a health service system's performance was also evident.

2. The community-based method of calculating per capita utilization rates which involved delineating a geographic area, summating the surgical utilization of all residents in the area (regardless of where the utilization occurred), and then dividing by the population size of the area, provided a viable method of comparing the surgical utilization rates among different areas in the province. The utility of using patient origin-destination data to compute utilization rates, and to identify typical travel patterns for patients was evident following analysis of the area rates undertaken in Chapter IV. With regard to the second major finding, it is postulated that the patterns of patient travel for surgical care and the patterns of resource commitment by hospitals likely reflected physician referral patterns, hospital size and the technical expertise available in different hospitals, the major travel routes in the province, and factors unique to individual patients.
3. It was recognized that although areas having rates higher or lower than the provincial rates had been identified, it was not known if too much or too little surgery was being performed, or if the area rates reflected the influence of unidentified epidemiological factors. Thus, establishment of surgical utilization rate standards for all areas in the province was viewed as premature given the lack of understanding regarding the relationship between surgical utilization and

potential determinant factors.

4. Due to the influence of diverse and complex determinant factors present among different areas in the province, the utilization rates obtained for the six surgical categories were related to the geographic location of the boundary lines used to delineate the areas studied. Thus, the variation of area surgical utilization rates was in part a consequence of the aggregation chosen for study. When aggregations were constructed such that all areas were as homogeneous as possible with respect to potential determinants of surgical utilization, comparison of the surgical rates associated with these areas revealed minimal variation among area rates. The converse was generally true when dissimilar factors were present among the areas studied.
5. The negligible degree to which patient residence could be used to explain the variation among district surgical utilization rates raised two important points. First, it is obviously necessary to identify other factors (e.g., physician practice patterns, epidemiological factors) which may have influenced, or have been associated with, the variation of utilization rates. Second, geographic location can in some instances be regarded as a proxy for surgical resource availability. If residence location does not satisfactorily explain rate variation among districts, then the previous assumption that the presence of surgical resources necessarily results in

elevated surgical rates may be invalid. As such, the importance of not making premature or superficial judgements concerning the implications of surgical utilization rate variation is apparent.

With regard to the original problem investigated, surgical utilization rate variation among areas in Alberta was found. The magnitude of variation was dependent upon the particular set of areas studied. The previous list of conclusions indicates the necessity of calculating meaningful utilization rates, and challenges the premise that geographic location can be used to account for the variation among district surgical utilization rates. In the following section recommendations arising from the findings and conclusions of this study are presented.

5.4 Recommendations

Following completion of this study four recommendations were made. It is recommended:

1. That factors other than geographic location be investigated with regard to the explanation of surgical utilization rate variation.
2. That the personnel in government planning departments refrain from establishing provincial surgical utilization rate standards or norms until further analyses identify the nature of the relationship between

determinant factors and utilization rates.

3. That researchers constructing geographic areas for the purpose of utilization rate analyses remain cognizant of the importance of matching known determinant factors in the proposed study areas such that, the reasons for utilization rate variation among areas, may be more easily identified.
4. That further research be conducted to assess:
    a. the degree of variation among area surgical utilization rates that should be considered unreasonable or beyond that due to chance;
    b. the reasons why particular areas in the province have consistently high or low surgical utilization rates;
    c. the relationship between discretionary and non-discretionary procedures with respect to the degree of rate variation found among geographic areas; and
    d. the relationship between practice patterns of specific physicians and utilization rates (this research to be initiated by the medical profession).

The answers to these questions should assist policy development with respect to setting standards for the rate of surgical utilization, and the regionalization of surgical services.

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APPENDIX A: METHODOLOGY SUPPLEMENT

A.1 Surgical Codes Used in the Study

A.2 Equations Used in Population Projections

A.3 Formula Used for Age-Sex Adjustments

A.4 General Hospital Districts

A.5 Calculation of Relevance and Commitment Indices

A.1 Surgical Codes Used in the Study

Alberta used the Hospital Adaptation of the International Classification of Diseases (H-ICDA, 1968) to code disease entities and surgical procedures from 1969 to 1973. In 1974 Alberta started using the second edition of the H-ICDA (H-ICDA-2, 1973). The categories of the H-ICDA cannot be perfectly translated into the H-ICDA-2 for all operations. However, the author has attempted to ensure that the categories chosen for study are compatible between the two coding systems.

The surgical categories and their associated codes are shown on the following pages. It is evident that the compatibility between the two systems is very good. Pertinent comments and discrepancies between the two coding systems are listed below.

1. Appendectomy: Neither the H-ICDA nor the H-ICDA-2 appendectomy categories include apendectomies that were performed incidental to other abdominal surgery, as only the primary operation codes were used to abstract data.

2. Caesarian Section: The two coding systems are identical except for the inclusion of "obstetrical hysterotomy" in H-ICDA-2 (74.8). However, this procedure has been removed from the data collection process by selecting only those cases with a primary diagnosis of 650.0 to 664.9, which limits selection to maternity cases only.

3. Hysterectomy: The two categories are identical except for the labelling of H-ICDA (71.3) and H-ICDA-2 (68.4). This difference in title has not changed the type of information collected, and therefore, the two categories are similar.

4. Cholecystectomy: The two categories are identical except for the number used to identify them (H-ICDA: 53.5, and H-ICDA-2: 51.1).

5. Prostatectomy: The individual categories H-ICDA 65.3 and 65.5 cannot be perfectly translated into H-ICDA-2 60.4 and 60.6. However, when the data are grouped together, the discrepancy between the two coding systems is minimal.

6. Tonsillectomy and Adenoidectomy: The individual categories of the two coding systems are not identical; more categories have been included in the H-ICDA-2 coding system. Since the different codes under each category are combined to yield one total, the lack of perfect matching should not influence the study results unduly.

SURGICAL CODES

Code Changes:

1969 - 1973 H-ICDA
1974 - 1978 H-ICDA-2

1969 - 1973 H-ICDA

a) Appendectomy	49.1
b) Caesarian Section	78.0, 78.1, 78.2, 78.8, 78.9
c) Hysterectomy	71.0, 71.1, 71.2, 71.3, 71.4
d) Cholecystectomy	53.5
e) Prostatectomy	65.1, 65.2, 65.3, 65.4, 65.5
f) Tonsillectomy and Adenoidectomy	23.0, 23.1, 23.2, 23.3

1974 - 1978 H-ICDA-2

a) Appendectomy	47.0
b) Caesarian Section	74.0, 74.1, 74.2, 74.8, 74.9 (select only those with primary diagnosis 650.0 to 664.9)
c) Hysterectomy	68.2, 68.3, 68.4, 68.5, 68.6
d) Cholecystectomy	51.1
e) Prostatectomy	60.2, 60.3, 60.4, 60.5, 60.6
f) Tonsillectomy and Adenoidectomy	28.0, 28.1, 28.2, 28.3, 28.4, 28.5

SURGICAL CODES

OPERATION	1969 - 1973 H-ICDA[1]		1974 - 1978 H-ICDA-2[2]	
Appendectomy	49.1	Appendectomy -with or without drainage	47.0	Appendectomy -with or without drainage
Caesarian Section (C-S)	78.0	C-S, classical -corporeal -incision into corpus of uterus -transperitoneal, classical -upper uterine segment	74.0	C-S, classical -corporeal -incision into corpus of uterus -transperitoneal, classical -upper uterine segment
	78.1	C-S, low cervical -incision into lower uterine segment -laparotrachelotomy -transperitoneal, low cervical	74.1	C-S, low cervical -incision into lower uterine segment -laparotrachelotomy -transperitoneal, low cervical
	78.2	C-S, extraperitoneal -Latzko's -Norton's -supravesical -Waters' -without incision of peritoneum	74.2	C-S, extraperitoneal -Latzko's -Norton's -supravesical -Waters' -without incision of peritoneum
	78.8	C-S, other specified type -peritoneal exclusion -transperitoneal NOS -vaginal	74.8	C-S, other specified type -obstetrical hysterotomy -peritoneal exclusion -transperitoneal NOS -vaginal
	78.9	C-S, type unspecified	74.9	C-S, type unspecified
Hysterectomy (Hys.)	71.0	Abdominal hys. subtotal -fundectomy, uterine -supracervical (supra-vaginal)	68.2	Abdominal hys. subtotal -fundectomy, uterine -supracervical (supra-vaginal)

OPERATION	1969 - 1973 H-ICDA[1]		1974 - 1978 H-ICDA-2[2]	
Hysterectomy (con't.)	71.1	Abdominal hys. total -panhysterectomy -removal of corpus and cervix uteri	68.3	Abdominal hys. total -panhysterectomy -removal of corpus and cervix uteri
	71.2	Abdominal hys. radical -removal of corpus, cervix, part of the vagina, and cellular tissue -Wertheim's operation	68.4	Vaginal hysterectomy
	71.3	Vaginal hys. total and subtotal	68.5	Abdominal hys. radical -removal of corpus, cervix, part of vagina, and cellular tissue -Wertheim's operation
	71.4	Vaginal hys. radical -removal of corpus, cervix, part of vagina, and cellular tissue -Schauta operation	68.6	Vaginal hys. radical -removal of corpus, cervix, part of vagina, and cellular tissue -Schauta operation
Cholecystectomy	53.5	Cholecystectomy -resection of gallbladder	51.1	Cholecystectomy -resection of gallbladder
Prostatectomy (Prost.)	65.1	Prost. suprapubic -complete -partial -punch	60.2	Prost. transurethral -electroresection -fulguration -loop -punch
	65.2	Prost. transurethral -electroresection -fulguration -loop -punch	60.3	Prost. suprapubic -complete -partial -punch
	65.3	Prost. perineal -complete -partial -punch	60.4	Prost. retropubic -complete -partial -punch

OPERATION	1969 - 1973 H-ICDA[1]	1974 - 1978 H-ICDA-2[2]
Prostatectomy (con't.)	65.4 Prost. radical -that by any approach	60.5 Prost. radical -that by any approach
	65.5 Prost. other -NOS -complete -partial -retropubic	60.6 Prost. other -NOS -complete -partial -perineal
Tonsillectomy and Adenoidectomy (T & A)	23.0 Incision and drainage of tonsil -drainage of peritonsillar abscess	28.0 Incision and drainage of tonsil and peritonsillar structures -drainage of abscess: parapharyngeal peritonsillar retropharyngeal tonsillar
	23.1 T without A -complete -excision of tonsil tag -partial -that by cryosurgery	28.1 T without A
	23.2 T with A	28.2 T with A
	23.3 A without T -excision of adenoid tag	28.3 Excision of tonsil tag
		28.4 Excision of lingual tonsil
		28.5 A without T -excision of adenoid tag

[1] Surgical categories copied from: Commission of Professional and Hospital Activities. H-ICDA Hospital adaptation of ICDA. Ann Arbor, Michigan, 1968, pages 538, 581, 586, 601-602, 620-621.

[2] Surgical categories copied from: Commission of Professional and Hospital Activities. H-ICDA Hospital adaptation of ICDA second edition. Ann Arbor, Michigan, 1973, pages 611, 641, 646, 664-665, 674-675, 684-685.

A.2 Equations Used in Population Projections

The following steps were employed to obtain the population projections used in this study.

Step 1: Census data for 1971 and 1976 were obtained.

Step 2: Age-sex adjustment of each district census population was done as outlined in Appendix A.3.

Step 3: The assumption of a constant yearly rate of service population increase or decrease unique to each district was made.

Step 4: The annual rate of service population increase or decrease was calculated in the following manner:

R = rate
P = service population
$\ln$ = natural logarithm
Exp = exponent

$$R = \mathrm{Exp}(\ln(P76/P71))/5$$

Step 5: The service population for each of the 102 general hospital districts was estimated for the years 1972 to 1975, and 1977 and 1978 using the following equations.

$$P72 = P71 \times R$$
$$P73 = P72 \times R$$
$$P74 = P73 \times R$$
$$P75 = P74 \times R$$
$$P77 = P76 \times R$$
$$P78 = P77 \times R$$

A.3 Formula Used for Age-Sex Adjustments[1]

$$N_{\cdot j} = \sum_k W_k P_{kj} \qquad 1.$$

Where P_{kj} is the sum of the number of residents in the k^{th} age-sex group in district j

W_k is a weight applicable to the k^{th} age-sex group and represents a relative per capita resource requirement for serving this specific age-sex group in comparison with the total population of the study area

$N_{\cdot j}$ is the age-sex adjusted number of residents in district j

W_k can be calculated in the following manner:

$$W_k = \frac{D_{k\cdot}}{P_{k\cdot}} \Big/ \frac{D_{\cdot\cdot}}{P_{\cdot\cdot}} \qquad 2.$$

Where $D_{k\cdot}$ denotes the total amount of utilization generated by the k^{th} age-sex group

$P_{k\cdot}$ represents the number of people in the k^{th} age group

$D_{\cdot\cdot}$ represents the total resources utilized

$P_{\cdot\cdot}$ represents the total number of persons in the study area

Thus

$$N_{\cdot j} = \sum_k W_k P_{kj} = \sum_k \frac{D_{k\cdot} P_{\cdot\cdot}}{D_{\cdot\cdot} P_{k\cdot}} P_{kj} \qquad 3.$$

The sum of all age-sex adjusted district populations yields the age-sex adjusted population for the entire study area.

$$N_{\cdot\cdot} = \sum_j N_{\cdot j} = \sum_j \sum_k W_k P_{kj} = \sum_k \sum_j W_k P_{kj} = \frac{P_{\cdot\cdot}}{D_{\cdot\cdot}} D_{\cdot\cdot} = P_{\cdot\cdot} \qquad 4.$$

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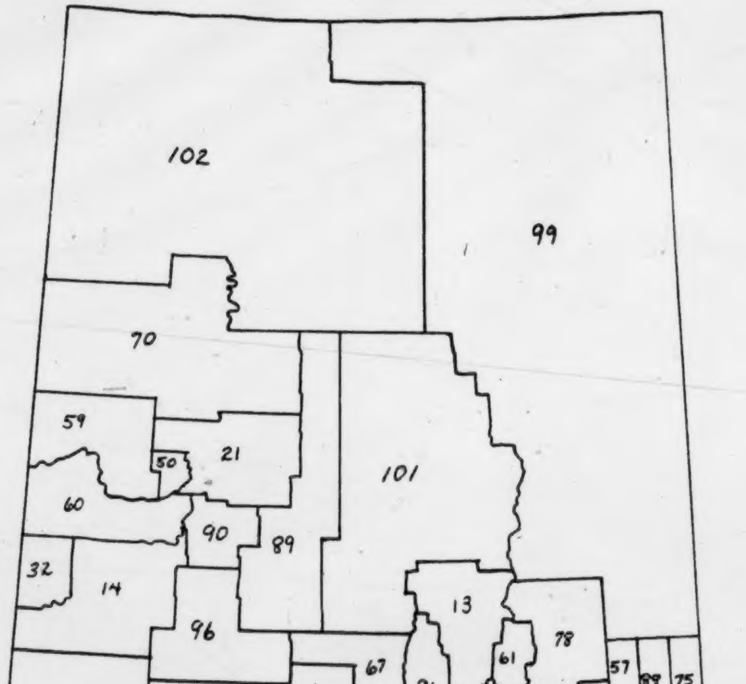
[1] **Source**: Bay, K. & Nestman, L. A hospital service population model and its application. *International Journal of Health Services*, 1980, *10*(4), 677-695.

A.4 General Hospital Districts

GHD No.	General Hospital District Name
1	Mannville
2	Vermilion
3	Drumheller
4	Islay
5	Cardston
6	Bassano
7	Drayton Valley
8	Lloydminster**
9	Hanna
10	Viking
11	High River
12	Provost
13	Athabasca
14	Grande Prairie
15	Red Deer
16	Innisfail
17	Wainwright
18	Elk Point
19	Vulcan
20	Stettler
21	Peace River
22	Consort
23	Myrnam
24	Claresholm
25	Little Bow
26	Olds
27	Taber
28	Brooks
29	Magrath
30	Eckville
31	Raymond
32	Beaverlodge-Hythe*
33	Didsbury
34	Vegreville
35	Oyen
36	St. Paul
37	Ponoka
38	Mayerthorpe
39	Coronation
40	Crowsnest Pass
41	Castor
42	Two Hills
43	Bently
44	Elnora
45	Three Hills
46	Cereal
47	Tofield
48	Fort Macleod
49	Rocky Mountain House
50	Berwyn
51	Sundre
52	Rimbey
53	Empress
54	Lacombe
55	Flagstaff-Hughenden*
56	Trochu
57	Glendon
59	Fairview
60	Spirit River
61	Boyle
63	Grande Cache
64	Lamont-Mundare-Willingdon*
65	Lethbridge*
66	Turner Valley
67	Barrhead
69	Medicine Hat
70	Manning
71	Banff
72	Bow Island
73	Smoky Lake
75	Cold Lake**
76	Hinton
78	La La Biche
79	Pincher Creek
80	Canmore
81	Wetaskiwin
82	Picture Butte
83	Leduc*
84	Stony Plain
85	Breton
86	Edson
87	Jasper
88	Bonnyville*
89	High Prairie
90	McLennan
91	Westlock
92	Camrose
93	Metro Calgary and Rural*
94	Bashaw
95	Border Counties
96	Valleyview
97	Whitecourt
98	Fort Saskatchewan
99	Fort McMurray
100	Sturgeon
101	Slave Lake
102	Fort Vermillion-High Level*
103	Thorhild County
105	Vilna
106	Metro Edmonton and Rural*
150	Blood Indian Reserve**
154	County of Wheatland**

* More than one hospital located in the district
** No hospital located in the district

General Hospital Districts



Source: Alberta Hospitals and Medical Care Annual Report, 1981.

A.5 Calculation of Relevance and Commitment Indices*

1. Relevance Index of a District to the Hospital(s) Located in the same district:

$$\frac{\text{Number of District Residents Separated from the District Hospital}}{\text{Total Number of District Residents Separated from all Hospitals in the Province}} \times 100$$

2. Relevance Index of a District to Hospital(s) Not Located in the same district:

$$\frac{\text{Number of District Residents Separated from all Non-District Hospitals}}{\text{Total Number of District Residents Separated from all Hospitals in the Province}} \times 100$$

3. Commitment Index of a Hospital to the District in which it is Located:

$$\frac{\text{Number of District Residents Separated from the District Hospital}}{\text{Total Number of Patients Separated from the Hospital}} \times 100$$

4. Commitment Index of a Hospital to all Districts Excluding the one in which it is Located:

$$\frac{\text{Number of Patients Separated from the Hospital who Resided in a District other than the one in which the Hospital is Located}}{\text{Total Number of Patients Separated from the Hospital}} \times 100$$

* In the above examples only separations are used in the calculation of the relevance and commitment indices. This is only one of several measures that can be used; for example, admission data or patient day data could be used.

APPENDIX B: RESULTS SUPPLEMENT

B.1 Distribution of Medical Practitioners 1973-1981

B.2 Days of Stay for Each of the Six Surgical Categories Expressed as a Percentage of Total Acute Care Utilization

B.3 Number of Surgical Separations and Days of Hospital Stay, Alberta, 1971, 1974, and 1978

B.4 Length of Stay Rates (in days) per 1000 Persons, Alberta, 1971-1978

B.5 District Perspective: Percentage of Area Residents Receiving Surgical Care at Selected Hospitals (Relevance Indices), 1971 and 1978

B.6 Average Length of Stay in Days of Patients Remaining In, and Travelling Out of Their Resident Area for Surgical Care, 1971 and 1978

B.7 Average Length of Stay in Days for Patients Remaining Within Each of the Six Areas For Surgical Care, 1971 and 1978

B.8 Hospital Perspective: Percentage of Surgical Separations Committed by Six Hospital Groups to Six Selected Areas (Commitment Indices), 1971 and 1978

B.9 Percentage of Total Surgical Separations and Days of Hospital Stay for Six Surgical Categories by Three Hospital Locations, 1971 and 1978

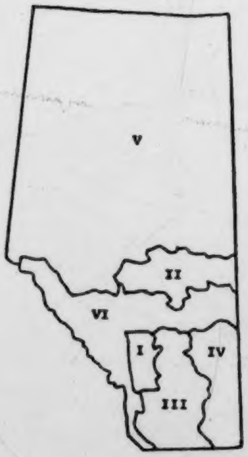
B.10 Percentage of Surgical Separations and Days of Hospital Stay for Six Surgical Categories By Six Hospital Locations, 1971 and 1978

Appendix B.1

Distribution of Medical Practitioners 1973 - 1981*

DISTRICT / YEAR	I CALGARY	II EDMONTON	III LETHBRIDGE	IV MEDICINE HAT	V PEACE RIVER	VI RED DEER	TOTAL
1973	661 (350)	1004 (517)	171 (46)	51 (19)	169 (10)	149 (31)	2205 (973)
1974	686 (361)	1025 (525)	171 (49)	49 (19)	175 (13)	150 (30)	2256 (997)
1975	711 (360)	1072 (541)	180 (55)	61 (20)	174 (13)	154 (30)	2352 (1019)
1976	733 (380)	1065 (530)	186 (56)	57 (17)	188 (12)	153 (31)	2382 (1026)
1977	743 (385)	1073 (542)	184 (59)	56 (18)	188 (14)	155 (31)	2399 (1049)
1978	776 (405)	1077 (549)	194 (63)	65 (22)	199 (15)	156 (33)	2467 (1087)
1979	807 (418)	1109 (571)	203 (68)	68 (26)	195 (19)	167 (39)	2549 (1141)
1980	828 (430)	1162 (572)	212 (71)	70 (25)	197 (22)	175 (40)	2644 (1160)
1981	877 (455)	1235 (600)	207 (70)	71 (26)	204 (25)	182 (42)	2776 (1218)

The bracketed numbers indicate the total number of specialists (includes laboratory, medical, and surgical specialists)



Year	Number
1973	430
1974	438
1975	447
1976	455
1977	469
1978	472
1979	580
1980	482
1981	496

* Tables and Map adapted from the Annual Reports of the Alberta Health Care Insurance Commission (1973-1978) and Alberta Hospitals and Medical Care - Health Care Insurance Plan (1979-1981)

Appendix B.2: Days of Stay for Each of the Six Surgical Categories
Expressed as a Percentage of Total Acute Care Utilization

Surgical Category	Year							
	1971	1972	1973	1974	1975	1976	1977	1978
Appendectomy	.99	.89	.86	.76	.75	.75	.73	.68
Caesarean Section	.57	.54	.64	.68	.80	.95	1.09	1.18
Prostatectomy	1.21	1.19	1.13	1.13	1.16	1.14	1.16	1.22
Cholecystectomy	2.66	2.59	2.54	2.20	1.99	1.85	1.73	1.70
Hysterectomy	2.08	2.05	2.02	1.91	1.85	1.65	1.64	1.57
Tonsillectomy and Adenoidectomy	1.13	.88	.81	.74	.78	.74	.66	.64
Total for All Six Categories	8.6	8.1	8.0	7.4	7.3	7.1	7.0	7.0

Appendix B.3: Number of Surgical Separations and Days of Hospital Stay, Alberta, 1971, 1974, and 1978

Surgical Category	Year and Utilization Measure[1]							
	1971		1974		1978		% increase or decrease 1971-1978	
	Sep.	Days	Sep.	Days	Sep.	Days	Sep.	Days
Appendectomy	4407	31360	3823	24564	3699	21493	-16	-31
Caesarean Section	1575	17926	2069	21858	4100	37301	+160	+108
Prostatectomy	1909	38157	2141	36458	2495	38359	+31	+1
Cholecystectomy	6489	84076	6087	70798	4685	53624	-28	-36
Hysterectomy	5867	65950	5940	61301	5340	49439	-9	-25
Tonsillectomy and Adenoidectomy	13988	35746	9656	23733	8563	20221	-39	-43

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1. Sep. refers to the number of separations, and days refers to the total number of days of hospital stay.

Appendix B.4: Length of Stay Rates (in days) per 1000 Persons, Alberta, 1971-1978

Surgical Category	Year							
	1971	1972	1973	1974	1975	1976	1977	1978
Appendectomy	19.3	17.9	16.3	14.0	13.3	12.8	12.1	11.1
Caesarean Section	11.0	10.9	12.1	12.5	14.2	16.2	18.0	19.3
Prostatectomy	23.4	23.9	21.2	20.8	20.7	19.5	19.2	19.8
Cholecystectomy	51.6	51.8	47.9	40.5	35.4	31.7	28.6	27.7
Hysterectomy	40.5	41.0	38.0	35.0	32.9	28.3	27.1	25.6
Tonsillectomy and Adenoidectomy	21.9	17.6	15.3	13.6	13.9	12.7	10.9	10.5

Appendix B.5: District Perspective: Percentage of Area Residents Receiving Surgical Care at Selected Hospitals (Relevance Indices), 1971 and 1978

Area of Patient Origin	Year	Hospital Destinations and Surgical Category[1]																							
		Calgary				Edmonton				Grande Prairie				Lethbridge				Medicine Hat				Red Deer			
		Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch
Calgary Area	1971	97	98	96	97	1	0	1	1	0	0	0	0	1	2	3	1	0	0	0	0	1	0	0	1
	1978	96	96	93	97	2	0	0	1	0	0	0	0	1	2	3	1	0	1	3	0	1	1	1	1
Edmonton Area	1971	0	0	0	0	99	99	99	99	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
	1978	0	0	0	0	99	99	99	99	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
Grande Prairie Area	1971	0	0	0	0	3	0	95	9	97	93	5	91	0	0	0	0	0	0	0	0	0	7	0	0
	1978	0	1	4	0	6	9	94	10	94	90	0	90	0	0	0	0	0	0	0	0	0	0	2	0
Lethbridge Area	1971	3	4	10	3	0	0	0	0	0	0	0	0	96	96	90	97	1	0	0	0	0	0	0	0
	1978	3	3	6	3	1	1	1	0	0	0	0	0	96	96	93	97	0	0	0	0	0	0	0	0
Medicine Hat Area	1971	5	0	5	2	0	0	0	1	0	0	0	0	2	8	5	8	93	92	90	89	0	0	0	0
	1978	3	0	2	3	2	1	0	2	0	0	0	0	21	2	5	7	74	97	93	88	0	0	0	0
Red Deer Area	1971	2	2	10	1	6	9	20	9	0	0	0	0	0	0	0	0	0	0	0	0	92	89	70	90
	1978	1	3	11	4	6	8	20	9	0	0	0	0	0	0	0	0	0	0	0	0	93	89	69	87

-see following page for three remaining surgical categories.

Appendix B.5: continued

Hospital Destinations and Surgical Category[1]

Area of Patient Origin	Year	Calgary			Edmonton			Grande Prairie			Lethbridge			Medicine Hat			Red Deer		
		Hy	TA	T	Hy	TA	T	Hy	TA	T	Hy	TA	T	Hy	TA	T	Hy	TA	T
Calgary Area	1971	96	98	97	0	0	0	0	0	0	3	1	2	0	0	0	1	1	1
	1978	96	97	96	0	0	0	0	0	0	3	1	2	0	1	1	1	1	1
Edmonton Area	1971	0	0	0	99	99	99	0	0	0	0	0	0	0	0	0	1	1	1
	1978	0	0	0	99	99	99	0	0	0	0	0	0	0	0	0	1	1	1
Grande Prairie Area	1971	0	1	0	16	3	9	84	96	91	0	0	0	0	0	0	0	0	0
	1978	1	0	1	17	8	14	82	92	85	0	0	0	0	0	0	0	0	0
Lethbridge Area	1971	1	2	3	0	0	0	0	0	0	99	98	97	0	0	0	0	0	0
	1978	2	2	3	0	0	0	0	0	0	98	98	97	0	0	0	0	0	0
Medicine Hat Area	1971	2	1	2	0	0	0	0	0	0	16	6	8	82	93	90	0	0	0
	1978	1	1	2	1	0	0	0	0	0	10	3	6	88	96	92	0	0	0
Red Deer Area	1971	3	2	3	9	4	7	0	0	0	0	0	0	0	0	0	94	94	90
	1978	5	1	3	7	8	9	0	0	0	0	0	0	0	0	0	88	91	88

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[1] The Calgary area includes districts 3, 6, 9, 11, 19, 24, 25, 26, 28, 33, 35, 40, 45, 46, 48, 51, 53, 56, 66, 71, 93, and 109. The Grande Prairie area includes districts 14, 32, 60, 63, and 96. The Lethbridge area includes districts 5, 27,29, 31, 65, 79, 82, 95, and 108. The Medicine Hat area includes districts 69 and 72. The Red Deer area includes districts 15, 16, 20, 22, 30, 39, 41, 43, 44, 49, and 54. The remainder of the districts were combined to form the Edmonton area. The following abbreviations were used for the surgical categories: Ap, Appendectomy; CS, Caesarean Section; Pr, Prostatectomy; Ch, Cholecystectomy; Hy, Hysterectomy; TA, Tonsillectomy and Adenoidectomy; and T, the total for all six surgical categories.

Appendix B.6: Average Length of Stay in Days of Patients Remaining In, and Travelling Out of Their Resident Area for Surgical Care, 1971 and 1978.

Surgical Category	Year	Resident Area of Patients[1]					
		Metropolitan Area		Regional Area		Rural Area	
		In	Out	In	Out	In	Out
Appendectomy	1971	6.8	6.6	7.2	6.6	7.3	9.3
	1978	5.7	6.0	5.8	5.0	5.7	7.3
Caesarean Section	1971	11.3	9.9	11.2	8.0	11.0	13.2
	1978	8.9	7.8	8.8	8.3	8.6	10.5
Prostatectomy	1971	20.1	22.3	21.2	28.9	21.5	19.0
	1978	15.7	16.0	15.6	20.4	17.2	14.6
Cholecystectomy	1971	13.0	12.4	11.9	13.7	12.7	14.1
	1978	11.8	8.6	10.5	16.3	10.1	12.7
Hysterectomy	1971	11.2	12.8	10.6	9.7	11.5	11.7
	1978	9.2	7.6	8.9	8.2	9.4	9.7
Tonsillectomy & Adenoidectomy	1971	2.3	3.1	2.6	2.7	2.9	2.6
	1978	2.3	2.4	2.2	2.3	2.5	2.4
Total for all 6 Surgical Categories	1971	8.0	7.1	7.9	10.4	6.5	12.1
	1978	7.8	5.5	7.3	8.7	5.7	10.2

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[1] The metropolitan area includes districts 83, 84, 93, 98, and 106. The regional area includes districts 14, 15, 65, and 69. The remaining districts were combined to form the rural area.

Appendix B.7: Average Length of Stay in Days for Patients Remaining Within Each of the Six Areas For Surgical Care, 1971 and 1978.

		Resident Area of Patients[1]					
Surgical Category	Year	Calgary	Edmonton	Grande Prairie	Lethbridge	Medicine Hat	Red Deer
Appendectomy	1971	7.4	7.0	6.1	7.2	8.3	6.6
	1978	5.5	6.0	5.0	5.5	7.6	6.2
Caesarean Section	1971	10.8	12.1	10.0	10.3	11.4	11.5
	1978	8.4	9.7	8.3	9.3	8.2	8.5
Prostatectomy	1971	20.9	19.1	17.0	20.1	19.3	21.8
	1978	14.8	15.7	-	16.4	12.4	15.7
Cholecystectomy	1971	14.1	12.6	10.7	11.4	12.0	12.9
	1978	11.2	11.8	9.4	10.8	9.6	11.9
Hysterectomy	1971	12.1	11.0	10.4	10.6	12.1	10.4
	1978	9.4	9.2	8.2	9.1	8.7	9.5
Tonsillectomy & Adenoidectomy	1971	2.5	2.6	2.8	2.7	2.2	2.3
	1978	2.3	2.5	2.4	2.4	2.1	2.2
Total for all 6 Surgical Categories	1971	8.5	7.8	5.7	7.5	8.3	7.4
	1978	7.5	7.8	5.9	7.4	6.8	7.4

1. The Calgary area includes districts 3, 6, 9, 11, 19, 24, 25, 26, 28, 33, 35, 40, 45, 46, 48, 51, 53, 56, 66, 71, 80, 93, and 109. The Grande Prairie area includes districts 14, 32, 60, 63, and 96. The Lethbridge area includes districts 5, 27, 29, 31, 65, 79, 82, 95, and 108. The Medicine Hat area includes districts 69 and 72. The Red Deer area includes districts 15, 16, 20, 22, 30, 39, 41, 43, 44, 49, and 54. The remainder of the districts formed the Edmonton Area.

Appendix B.8: Hospital Perspective: Percentage of Surgical Separations Committed by Six Hospital Groups to Six Selected Areas (Commitment Indices), 1971 and 1978

Area of Patient Origin	Year	Area of Patient Origin and Surgical Category[1]																							
		Calgary				Edmonton				Grande Prairie				Lethbridge				Medicine Hat				Red Deer			
		Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch	Ap	CS	Pr	Ch
Calgary Area Hospitals	1971	98	99	94	99	1	0	0	0	0	0	0	0	1	1	3	1	0	0	1	0	0	0	2	0
	1978	98	98	95	98	1	0	0	0	0	0	0	0	1	1	2	1	0	0	0	0	0	1	3	1
Edmonton Area Hospitals	1971	1	0	0	0	98	98	93	98	0	1	4	1	0	0	0	0	0	0	0	0	1	1	3	1
	1978	1	0	0	1	98	98	94	97	0	1	3	1	0	0	0	0	0	0	0	0	1	1	3	1
Grande Prairie Area Hospitals	1971	0	0	0	0	3	5	33	8	96	95	67	92	0	0	0	0	0	0	0	0	1	0	0	0
	1978	1	0	0	2	4	3	0	5	95	97	0	93	0	0	0	0	0	0	0	0	0	0	0	0
Lethbridge Area Hospitals	1971	4	7	9	5	1	0	0	0	0	0	0	0	95	91	89	92	0	2	2	3	0	0	0	0
	1978	5	10	11	5	0	0	1	0	0	0	0	0	90	89	86	92	5	1	2	3	0	0	0	0
Medicine Hat Area Hospitals	1971	2	3	2	5	3	0	0	0	0	0	0	0	2	0	0	0	93	97	98	95	0	0	0	0
	1978	4	15	23	2	0	0	0	0	0	0	0	0	0	1	0	0	96	84	77	98	0	0	0	0
Red Deer Area Hospitals	1971	4	0	1	5	2	4	7	4	0	0	0	0	0	0	0	0	0	0	0	0	94	96	92	91
	1978	3	6	5	3	3	4	5	5	0	0	0	0	0	0	0	0	0	0	0	0	94	90	90	92

-see following page for three remaining surgical categories.

Appendix B.8: continued

Area of Patient Origin	Year	Calgary Hy	Calgary TA	Calgary T	Edmonton Hy	Edmonton TA	Edmonton T	Grande Prairie Hy	Grande Prairie TA	Grande Prairie T	Lethbridge Hy	Lethbridge TA	Lethbridge T	Medicine Hat Hy	Medicine Hat TA	Medicine Hat T	Red Deer Hy	Red Deer TA	Red Deer T
Calgary Area Hospitals	1971	99	99	98	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1
	1978	98	99	98	0	0	0	0	0	0	1	1	1	0	0	0	1	0	1
Edmonton Area Hospitals	1971	0	0	0	98	99	98	1	0	1	0	0	0	0	0	0	1	1	1
	1978	0	0	0	98	98	98	1	1	1	0	0	0	0	0	0	1	1	1
Grande Prairie Area Hospitals	1971	0	0	0	3	0	3	97	100	97	0	0	0	0	0	0	0	0	0
	1978	0	0	0	3	0	3	97	100	97	0	0	0	0	0	0	0	0	0
Lethbridge Area Hospitals	1971	9	4	6	0	0	0	0	0	0	87	94	92	4	2	2	0	0	0
	1978	11	5	8	0	0	0	0	0	0	86	94	90	3	1	2	0	0	0
Medicine Hat Area Hospitals	1971	3	3	3	0	0	1	0	0	0	0	0	0	97	97	96	0	0	0
	1978	5	10	10	0	0	0	0	0	0	2	1	1	93	89	89	0	0	0
Red Deer Area Hospitals	1971	3	3	3	5	2	3	0	0	0	0	0	0	0	0	0	92	95	94
	1978	4	4	4	6	4	5	0	0	0	0	0	0	0	0	0	90	92	91

Column heading: Area of Patient Origin and Surgical Category[1]

[1] The Calgary area includes districts 3, 6, 9, 11, 19, 24, 25, 26, 28, 33, 35, 40, 45, 46, 48, 51, 53, 56, 66, 71, 93, and 109. The Grande Prairie area includes districts 14, 32, 60, 63, and 96. The Lethbridge area includes districts 5, 27,29, 31, 65, 79, 82, 95, and 108. The Medicine Hat area includes districts 69 and 72. The Red Deer area includes districts 15, 16, 20, 22, 30, 39, 41, 43, 44, 49, and 54. The remainder of the districts were combined to form the Edmonton area. The following abbreviations were used for the surgical categories: Ap, Appendectomy; CS, Caesarean Section; Pr, Prostatectomy; Ch, Cholecystectomy; Hy, Hysterectomy; TA, Tonsillectomy and Adenoidectomy; and T, the total for all six surgical categories.

Appendix B.9: Percentage of Total Surgical Separations and Days of Hospital Stay for Six Surgical Categories by Three Hospital Locations, 1971 and 1978

Surgical Category	Year	Location of Hospital and Indicator[1]					
		Metropolitan Area		Regional Area		Rural Area.	
		Sep.	Days	Sep.	Days	Sep.	Days
Appendectomy	1971	49	47	11	12	40	41
	1978	54	55	13	13	33	32
Caesarean Section	1971	63	64	16	16	21	20
	1978	67	68	16	16	17	16
Prostatectomy	1971	80	79	17	17	3	4
	1978	81	81	18	18	1	1
Cholecystectomy	1971	67	68	12	11	21	21
	1978	66	69	14	13	20	18
Hysterectomy	1971	71	72	14	13	15	15
	1978	72	72	14	14	14	14
Tonsillectomy & Adenoidectomy	1971	55	51	11	11	34	38
	1978	53	52	13	12	34	36
Total for all 6 Surgical Categories	1971	61	65	12	13	27	22
	1978	63	69	14	14	23	17

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1. The metropolitan area includes districts 83, 84, 93, 98, and 106. The regional area includes districts 14, 15, 65, and 69. The remaining districts were combined to form the rural area. Sep. refers to the percentage of total separations and days refers to the percentage of total days of hospital stay.

Appendix B.10: Percentage of Surgical Separations and Days of Hospital Stay for Six Surgical Categories By Six Hospital Locations, 1971 and 1978

		Location of Hospital and Indicator[1]											
		Calgary		Edmonton		Grande Prairie		Lethbridge		Medicine Hat		Red Deer	
Surgical Category	Year	Sep.	Days	Sep.	Days	Sep.	Days	Sep.	Days	Sep.	Days	Sep.	Days
Appendectomy	1971	28	29	50	50	4	3	8	8	2	2	8	8
	1978	29	27	50	52	4	4	9	8	1	2	7	7
Caesarean Section	1971	37	36	41	44	3	2	11	10	2	2	6	6
	1978	33	31	47	50	3	3	7	7	3	2	7	7
Prostatectomy	1971	33	35	50	47	0	0	9	9	3	3	5	6
	1978	31	29	51	52	0	0	9	10	4	3	5	6
Cholecystectomy	1971	32	35	49	48	3	2	7	6	3	3	6	6
	1978	30	29	52	54	3	2	7	7	3	3	5	5
Hysterectomy	1971	30	32	51	50	2	2	9	8	2	2	6	6
	1978	35	35	47	47	2	2	8	8	2	2	6	6
Tonsillectomy & Adenoidectomy	1971	30	29	49	50	4	4	9	9	2	2	6	6
	1978	29	28	50	52	3	3	8	8	4	3	6	6
Total for all 6 Surgical Categories	1971	31	33	49	48	3	3	9	8	2	2	6	6
	1978	31	30	50	51	2	2	8	8	3	3	6	6

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[1] The Calgary area includes districts 3, 6, 9, 11, 19, 24, 25, 26, 28, 33, 35, 40, 45, 46, 48, 51, 53, 56, 66, 71, 80, 93, and 109. The Grande Prairie area includes districts 14, 32, 60, 63, and 96. The Lethbridge area includes districts 5, 27, 29, 31, 65, 79, 82, 95, and 108. The Medicine Hat area includes districts 69 and 72. The Red Deer area includes districts 15, 16, 20, 22, 30, 39, 41, 43, 44, 49, and 54. The remainder of the districts formed the Edmonton area. Sep. refers to the percentage of total separations and days refers to the percentage of total days of hospital stay.